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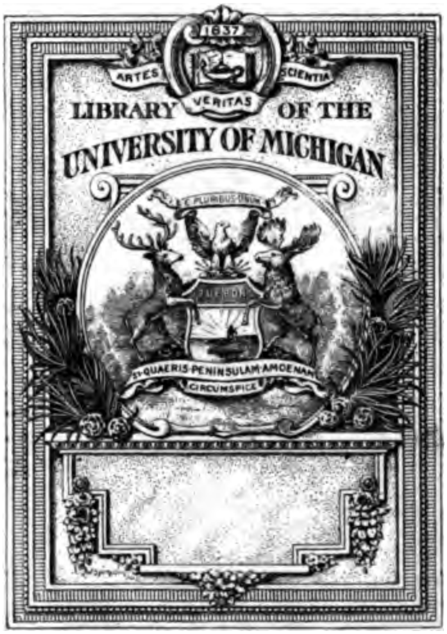

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REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE FIRST SESSION OF THE FIFTY-FIRST CONGRESS.

IN FOUR VOLUMES.

VOLUME III.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1889.

REPORT OF THE CHIEF OF ORDNANCE.

WAR DEPARTMENT, ORDNANCE OFFICE,
Washington, October 10, 1889.

SIR: I have the honor to submit the following report of the principal operations of the Ordnance Department during the fiscal year ended June 30, 1889, with such remarks and recommendations as the interests of this branch of the military service seem to require.

The fiscal resources and expenditures of the Department during the year were as follows, viz:

Amount in the Treasury to the credit of the appropriations on June 30, 1888	$341,774.57
Amount in the Treasury not reported to the credit of the appropriations on June 30, 1888	1,020.48
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1888	157,850.89
Amount of appropriations for the service of the fiscal year ended June 30, 1889	5,699,148.65
Amounts refunded to ordnance appropriations in settling accounts during the fiscal year ended June 30, 1889	25,996.22
Gross amount received during the fiscal year ended June 30, 1889, from sales to officers; from rents; from collections from troops on account of losses of, or damage to, ordnance stores; from Chicago, Rock Island and Pacific Railroad Company; from powder and projectiles (proceeds of sales); from sales of condemned stores; from testing machine, and from all other sources not before mentioned	56,031.80
Total	6,281,822.61
Amount of expenditures during the fiscal year ended June 30, 1889, including expenses attending sales of condemned stores, exchange of powder, etc	1,537,836.95
Amount deposited in Treasury during the fiscal year ended June 30, 1889, as proceeds of sales of Government property	40,494.85
Amount turned into the surplus fund on June 30, 1889	41,728.89
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1889	320,242.11
Amount transferred from ordnance appropriations in settling accounts during the fiscal year ended June 30, 1889	455.86
Amount in the Treasury not reported to the credit of appropriations on June 30, 1889	618.97
Amount in the Treasury to the credit of appropriations on June 30, 1889	4,340,444.96
Total	6,281,822.61

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SECURING SUPPLIES.

vised Statutes requires all supplies to be pro- sement and competitive bidding. From the d about five years ago it was not construed to of every article for use in the service. It was supplies" referred to in the law had reference to the well-known needs of the public service required in its different branches for its successful and eco- mon. The law was evidently intended to guard the in- vernment and secure, by inciting a healthy competition the needed supplies at fair prices. This law was enacted the purchases were of great magnitude. It had then and good effect in enabling the Government to purchase at low when the quantity of supplies procured is of any considerable

five years ago the accounting officers of the Treasury held that law was applicable to *all* purchases of material and supplies both and small except when a public exigency existed requiring an immediate delivery, in which case purchases could be made in open market without advertisement or contract.

The enforcement of this view of the law in the case of small purchases has resulted in loss to the United States in both time and money as well as in the quality of the supplies procured, and I do not think that the framers of the law ever intended that it should apply to the purchase of the small articles occasionally needed in our manufacturing establishments.

The reports herewith from the commanding officers of ordnance establishments (Appendix 9), after a trial of nearly five years, show conclusively that small purchases can not be made as advantageously under the present construction of existing law as they could be if permitted to be made in open market in the manner common among business men.

To meet such cases and to put an authoritative construction on the law which will place the United States on as favorable a footing as the individual purchaser of like small supplies, I would recommend in the interest of a true public economy that section 3709, Revised Statutes, be amended by inserting after the word "services" on the first line the words "in excess of two hundred dollars," so that the section shall then read:

> SEC. 3709. All purchases and contracts for supplies or services *in excess of two hundred dollars*, in any of the Departments of the Government, except for personal services, shall be made by advertising a sufficient time previously for proposals respecting the same, when the public exigencies do not require the immediate delivery of the articles or performance of the service. When immediate delivery or performance is required by the public exigency, the articles or service required may be procured by open purchase or contract, at the places and in the manner in which such articles are usually bought and sold, or such services engaged between individuals.

The Interior Department makes purchases in open market to the amount of $500, under existing law.

CLERICAL FORCE.

The estimate to be laid before Congress calls for five additional clerks of class two for this office. Four of these five additional clerks asked for are in lieu of the four which have been on duty in this office since 1886 detailed from the Surgeon-General's Office but which were withdrawn from this office and returned to the Surgeon-General's Office under orders from the Secretary of War August 20, 1889, in order to expedite the settlement of pension applications. Authority was granted this office to estimate for a sufficient clerical force to supply the needs of the Ordnance Office, and meet the largely increased work due to the large appropriations for gun construction and to the labor required under the act of February 12, 1887, for arming and equipping the militia; and the grade of class *two* is asked for to permit the promotion of clerks of class *one* who have been very many years in the service and are capable, efficient and valuable. Promotion is the proper, and indeed the only, reward that can be held out for long, faithful, intelligent and efficient service, and that reward should be provided by Congress. I strongly recommend this small increase of the force, knowing full well that the slight additional expense will be amply repaid by more hearty and efficient service.

ORDNANCE MECHANICS FOR THE LIGHT BATTERIES.

The use of the new steel field guns and carriages occasionally necessitates minor repairs, in the more or less complicated details of their working parts, and the services of a mechanic skilled in the making and adjustment of gun and carriage construction are absolutely required. Each light battery should have one such employé in its command, provided with all the tools needed for such important and delicate work. I know of no better way than to educate a number of well-selected ordnance soldiers for this special duty, by a course of instruction and practical work at the gun factory and the National Armory. The successful candidates to be promoted to the grade of sergeants of ordnance and assigned to the light batteries. As soon as the new steel guns are provided and mounted on our forts, one or more of these sergeants will have to be assigned to each fort to keep the armament in working order, make repairs, and keep all things in proper preservation. Section 1163, Revised Statutes, provides fully for such details by giving the necessary authority to the Secretary of War.

NATIONAL ARMORY.

Manufactures and repairs of arms, etc., during the fiscal year.

Forty-one thousand two hundred and seventy-two rifles and carbines, besides swords, sabers, hospital corps knives, spare parts and appendages for the arms have been manufactured during the year. In addition to this regular manufacture, steel bayonet scabbard bodies, life-saving service gun carriages, machine gun feed guides and hoppers, 3.2″ field gun limbers, caisson, battery wagon and forge have also been made. Repairs and alterations of small-arms, machine guns, etc., and usual repairs of machinery and buildings have been carried on.

Buildings erected, completed, etc.

A new iron and brick fire-proof milling shop, 279 feet long, begun the previous year, has been completed ready for machines, in "Federal Square," in line with the old filing and machine-shops. The work of transferring the machines from the old milling shop began with the new fiscal year.

A new iron and brick fire-proof carpenter and stocking shop has been built and completed, except some interior wood work and fixtures, in Federal Square, of the dimensions and plans of the new milling shop, opposite to and parallel with it, 430 feet distant.

To complete this fire-proof plant, a building has been planned and estimated for which is to contain, with new engine and boilers in the center, all the other departments of the armory finishing shops. It is to be 458 feet long, connecting the new milling, and carpenter and stocking shops, forming with them three sides of a "square," and with these buildings and the old milling shop and connected buildings a quadrangle. Until this building be erected the new carpenter and stocking shop can not be occupied.

Connection with the existing power plant, for power for the new milling shop, is made by extension of the present machine-shop shafting under Federal street.

It is estimated that the present power plant, which is to remain intact, will be able to run all the new shops in an emergency, should the new engine from any cause be stopped, and at the same time will be available for the old shops retained (not torn down), if it should become necessary to expand beyond the capacity of the new fire-proof plant.

The rebuilding of the sustaining wall of Mill River below the water shops' dam has been in progress during the year, as previously, and it will take several years more to complete it. This work was made necessary by the incorporation with good material of much inferior stone when the walls were built, thirty-four years ago.

Small caliber rifle and magazine arm, rifle practice, etc.

In the absence of a suitable small-arms powder there has been no substantial progress in the matter of a small caliber rifle beyond what has been heretofore reported except in the negative gain resulting in the apparent abandonment, or tendency that way, abroad of all powders but the so-called smokeless. This change, involving the return to a *grained* powder, is, if permanent, an appreciable gain for all in the economy and efficiency of the product used in the manufacture of small-arm cartridges, and may have been brought about as much from the difficulty of obtaining uniform and satisfactory results in the way of velocities and pressures with the compressed powders as from the more valuable properties of the smokeless.

No American has yet submitted for trial a smokeless powder, and experiment with compressed powders has shown the same eccentricity as was developed abroad, tending to destroy confidence in the final production of a serviceable compressed powder cartridge. All effort, official and otherwise, to date, to obtain a smokeless powder has been abortive, and American powder makers and chemists have not yet awakened to the lucrative opportunity presented to them.

There is reason to believe from an application made to an officer of the Department more than ten years ago that smokeless powders originated, like many other inventions, in America, only to be brought to the attention of the world in foreign countries, although in this instance the person concerned met with encouragement—encourgement of which he did not avail himself.

In view of the present status of the powder question it is not deemed expedient to produce a small caliber rifle for compressed powder cartridges. Such a rifle, however excellent in itself, would be inferior to foreign arms using smokeless powders, and, consequently, unsatisfactory to the Army and the country at large. It is believed, however, that all the elements entering into the problem except the powder are ready for use the moment this powder is obtained. A .30 caliber rod-bayonet Springfield rifle has been made, and a rod-bayonet .30 caliber magazine arm is now in progress of construction in anticipation of the final acquisition of the much-needed powder, so that no time may be lost in presenting for trial both single-loading and magazine small caliber rifles.

The testing weekly of a number of the current manufacture of rifles by expert marksmen on the armory rifle ranges serves to maintain the excellence of the Springfield caliber .45 rifle, with which a team of American riflemen (Massachusetts volunteer militia) has recently won five successive contests abroad with five different teams of English volunteers.

Two of the American team are workmen of the armory and members of the Armory Rifle Club, which performs the duty aforesaid of testing Springfield rifles. The members of this club, all armory workmen, combine, generally, the excellence of skilled mechanics with that of expert marksmen, having few if any superiors. The practice on the ranges the past year has shown no falling off in the excellence of the rifle. On the contrary, for several years there appears to have been a progressive gain in accuracy.

ROCK ISLAND ARSENAL.

Work has been continued on the new office, armory shop K and storehouse K, and the underground shafting is now completed from shop A to shop G.

A temporary dam has been constructed to furnish water-power for the arsenal and to be used as a coffer-dam when the permanent dam is reconstructed. The work of repairing and reconstructing the dikes and embankments of the water-power pool is in progress, and contracts have been made and stone delivered for reconstructing the permanent dam, and repairing the draw-pier of the Rock Island Bridge.

Attention is called to the report of the commanding officer Rock Island Arsenal, which forms an appendix to this report, on the condition of the Rock Island Bridge. To make this bridge perfectly safe for railway travel will require the renewal of nearly all the timbers in the upper deck and their replacement, preferably with iron. An appropriation for this purpose is earnestly recommended.

The sundry civil appropriation act approved March 2, 1889, contains an appropriation of $35,000 for the construction of a viaduct from the south end of the wagon bridge between Rock Island and the city of Rock Island, over the railroad tracks which adjoin the approach to said bridge, with a proviso that the work shall not be commenced until the city of Rock Island shall deposit in the Treasury of the United States one-half of this amount towards reimbursing the United States for this expenditure.

The Hon. W. H. Gest, Representative in Congress from the Eleventh Congressional district of Illinois, represents that this proviso requiring the city of Rock Island to pay one-half the expense of building this viaduct is based upon an erroneous idea that that city has some peculiar interest therein, and recommends that Congress be asked to repeal the proviso. The commanding officer of Rock Island Arsenal indorses his views, and I concur therein and recommend the repeal of the proviso. All the papers in the case are submitted herewith, and marked Appendix 26*a*.

COLUMBIA ARSENAL.

The provisions of law having been duly complied with, the site selected for this arsenal was formally accepted by the Department. The principal buildings, main roads and sewers have been located and plans for the same have been prepared, submitted and approved. The buildings to be built under the present appropriation are the following: Store-house, repairing shop, barracks, quarters for married enlisted men, office, guard-house and a set of officers' quarters.

ARMAMENT OF FORTIFICATIONS.

The act making appropriations for fortifications and other works of defense, for the armament thereof, and for other purposes, approved September 22, 1888, contains the following provisions and items touching the estimates submitted by the Ordnance Department, namely:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the appropriations hereinafter provided for shall be available until expended and shall be expended under the direct supervision of a board to

consist of the Commanding General of the Army, an officer of engineers, an officer of ordnance, and an officer of artillery, to be selected by the Secretary of War, to be called and known as the Board of Ordnance and Fortification; and said Board shall be under the direction of the Secretary of War and subject to his supervision and control in all respects, and shall have power to provide suitable regulations for the inspection of guns and materials at all stages of manufacture to the extent necessary to protect fully the interests of the United States, and generally to provide such regulations concerning matters within said Board's operations as shall be necessary to carry out to the best advantage all duties committed to its charge: *Provided*, That subject to the foregoing provisions the expenditure shall be made by the several bureaus of the War Department having jurisdiction of the same under existing law.

SEC. 2. That the sums of money herein provided for be, and the same are hereby, appropriated, out of any moneys in the Treasury not otherwise appropriated, namely:

SEC. 3. For the completion of the guns now under fabrication by the Ordnance Department and for testing the same, and for the manufacture or purchase and test of cannon and carriages, including carriages maneuvered by power, one of which shall be a disappearing carriage, and also including those for the field and siege services; for the alteration of carriages on hand to adapt them to improved service guns; for projectiles, powders, fuzes, and implements, their trial and proof; for experiments in the means of protecting torpedo lines; for compensation of draughtsmen while employed in the Army Ordnance Bureau on ordnance construction, and for the necessary expenses of ordnance officers while temporarily employed at the proving-ground and absent from their proper stations, at the rate of two dollars and fifty cents per diem while so employed, five hundred thousand dollars, and not more than ten thousand dollars of said sum shall be expended for providing increased facilities for the manufacture of projectiles; for examining, testing, and experimenting with pneumatic or other dynamite guns, gun-carriages, aerial torpedoes, dynamite shells and ammunition, and batteries for coast defense, whether sunken, counterpoise, or otherwise, brought to the notice of said Board, one hundred thousand dollars, or so much thereof as may be deemed proper: *Provided*, That all material purchased under this section, excepting samples, shall be of American manufacture.

SEC. 4. For the erection, purchase, or manufacture of the necessary buildings and other structures, machinery, tools, and fixtures for an army gun-factory for finishing and assembling heavy ordnance, to be erected at the Watervliet Arsenal, West Troy, New York, seven hundred thousand dollars: *Provided*, That not exceeding twenty thousand dollars of this sum may be used for the erection and completion of two sets of officers' quarters.

For the purchase of rough-finished, oil-tempered, and annealed steel for high-power coast-defense guns of eight, ten, and twelve inch caliber, in quality and dimensions conforming to specifications, subject to inspection at each stage of the manufacture, and including all the parts of each caliber, one million five hundred thousand dollars: *Provided*, That no money shall be expended except for steel accepted and delivered, and no contract shall be made hereunder for gun steel at a greater average price per pound for each caliber than the lowest average price paid under contracts hitherto made by the Government for American forgings of like caliber.

The material for the guns provided for herein shall be purchased in accordance with section 3709, Revised Statutes, for which purpose the Secretary of War is authorized to make contracts with responsible steel manufacturers, who shall be resident citizens of the United States, after proper advertisement, continuing not less than thirty days in the newspapers most likely to reach the said manufacturers: *Provided*, That each bidder with whom such contracts shall be made, shall have, or agree to erect, in the United States a suitable plant, including the best modern appliances, capable of making all the steel required, and of finishing it in accordance with the contracts, and shall further agree to deliver yearly a specified quantity of each caliber, the time of the delivery of the steel for the smaller calibers of heavy guns to commence at the expiration of not more than eighteen months, and that for the largest calibers, specified in the advertisement, at the expiration of not more than three years from the date of the acceptance of the contracts; and that all the tools, machines, and material for said guns shall be manufactured in the United States.

SEC. 5. For the purchase of the material for, and the manufacture of, 12-inch breech-loading rifled mortars of cast-iron, hooped with steel, of about 32,000 pounds weight, similar to, and equal in range, power, and accuracy of fire to the 12-inch breech-loading mortar, cast-iron, steel-hooped, now at the ordnance proving ground, Sandy Hook, New Jersey, said mortars to be subject to inspection in all stages of manufacture, $250,000.

The following items also are embodied in the act making appropriations for the sundry civil expenses of the Government, and for other purposes, approved October 2, 1888:

WATERVLIET ARSENAL, WEST TROY, NEW YORK: For a hand-power loading-crane, fifty tons capacity, for use in shops, three thousand dollars;

For two traveling cranes, thirty tons capacity, for use in workshops, twenty-four thousand dollars;

For crab, blocks, hooks, chains, and so forth, capacity fifty tons, for shrinkage-pit, four thousand eight hundred and fifty dollars;

For new machinery to bring the plant up to a modern standard, and to replace that which is obsolete and worn out, five thousand dollars;

For necessary railway facilities in arsenal grounds, connecting shops with Delaware and Hudson Canal Company Railroad, Erie Canal, and with the Hudson River, eight thousand four hundred and fifty-eight dollars;

For replacing the present old and unsuitable wooden bridge over the Erie Canal with an iron bridge adapted to the present wants of the arsenal, capacity one hundred and thirty tons, fifteen thousand dollars;

For two steam-boilers for running steam-engine at shops, and for heating purposes, eight thousand dollars; in all, sixty-eight thousand three hundred and eight dollars.

In accordance with the provisions of the act approved September 22, 1888, a board of officers, designated as the "Board of Ordnance and Fortification," was appointed to meet on October 30, 1888, consisting of the major-general commanding the Army, Maj. Gen. John M. Schofield; a colonel of engineers, Col. Henry L. Abbot; a colonel of artillery, Col. Henry W. Closson; and a lieutenant-colonel of ordnance, Lieut. Col. Alfred Mordecai. On the assembling of this Board, on October 30, the Department submitted for its consideration and approval the plans, specifications, and forms of proposals for bidders relative to steel forgings for 8-inch, 10-inch, and 12-inch guns provided for under section 4; also for the 12-inch breech-loading rifled mortars of cast-iron hooped with steel, provided for under section 5, and a detailed estimate of proposed expenditures under section 3 of the act.

The Board returned the papers pertaining to the steel gun forgings and the mortars on November 6, recommending favorable action, which was approved by the Secretary of War and the papers transmitted to the Ordnance Bureau on November 9. On the same date the Bureau made application for authority to publish advertisements inviting proposals in the newspapers throughout the country, which request was granted on November 12, and on November 13 the advertisements were sent out to the different newspapers designated. The bids for the steel forgings were opened on December 20, 1888, and for the mortars on December 15, 1888, the accepted bids being as follows:

Steel forgings for 8-inch, 10-inch, and 12-inch guns

Bid of the Bethlehem Iron Company, South Bethlehem, Pa., for the following-described complete sets of rough-finished, oil-tempered, and annealed steel forgings, of American manufacture, for 8-inch, 10-inch, and 12-inch guns at the following prices as specified in their proposal dated December 18, 1888, viz:

Twenty-three sets steel forgings for 8-inch rifles at—

Twenty-seven and one-third cents per pound, if the first set is delivered in twelve months from date of contract;

Twenty-five and one-third cents per pound, if the first set is delivered in fifteen months from date of contract;

Twenty-four cents per pound, if the first set is delivered in eighteen months from date of contract;

The remaining twenty-two sets to be delivered at the rate of eighteen sets every twelve months after the delivery of the first set until the whole number contracted for is delivered.

Twenty-three sets steel forgings for 10-inch rifles at—

Thirty and one-half cents per pound, if the first set is delivered in twenty-four months from date of contract;

Twenty-nine and one-half cents per pound, if the first set is delivered in twenty-seven months from date of contract;

Twenty-eight and one-half cents per pound, if the first set is delivered in thirty months from date of contract;

Twenty-seven and one-half cents per pound, if the first set is delivered in thirty-three months from date of contract;

Twenty-six and one-half cents per pound, if the first set is delivered in thirty-six months from date of contract;

The remaining twenty-two sets to be delivered at the rate of twelve sets every twelve months after the delivery of the first set until the whole number contracted for is delivered.

Fifteen sets steel forgings for 12-inch rifles at—

Thirty and one-half cents per pound, if the first set is delivered in twenty-seven months from date of contract;

Twenty-nine and one-half cents per pound, if the first set is delivered in thirty months from date of contract;

Twenty-eight and one-half cents per pound, if the first set is delivered in thirty-three months from date of contract;

Twenty-seven and one-half cents per pound, if the first set is delivered in thirty-six months from date of contract;

The remaining twelve sets to be delivered at the rate of six sets every twelve months after the delivery of the first set until the whole number contracted for is delivered.

The only other bidder on these forgings was the Midvale Steel Company, Philadelphia, Pa.

A contract with the Bethlehem Iron Company for supplying the forgings described in its bid was duly executed under date of January 31, 1889, and contains, among other stipulations, the following:

It is further stipulated and agreed that the party of the first part will furnish such limited additional forgings as above and at the prices stated, as the party of the second part may desire, under the present available appropriation.

It is further stipulated and agreed that if the forgings herein contracted for are not delivered by the party of the first part at the latest times specified herein for each caliber respectively, a penalty of two-tenths of a cent per pound per month on the price of each set of forgings for each month of delay in delivery thereafter shall be imposed on the said party of the first part, and all penalties incurred under this contract shall be off-set, from time to time, against any payment or payments falling due to the said party of the first part; the time allowed under paragraph 13, part 1, of the specifications to replace finally-rejected forgings not to be considered in imposing penalties under this clause of this contract.

Following is a tabulated statement giving the weights of the different sets of forgings, the highest price per pound, etc.:

Forgings.	Weight of set.	Cost per pound.	Cost per set.	No. of sets.	Total cost.
	Pounds.	*Cents.*			
8-inch gun	40,091	27⅓	$10,958	23	$252,039
10-inch gun	82,002	30½	25,011	23	575,244
12-inch gun	138,732	30½	42,318	15	634,699

The estimated total money value of the above contract is thus $1,461,982, leaving a balance of $38,018 with which to cover contingencies or any discrepancies as to weights, and of which a sufficient amount will still remain to procure one more set of forgings for a 10-inch gun, thus making a total of twenty-three 8-inch guns, twenty-four 10-inch guns and fifteen 12-inch guns.

The lowest average prices paid for American forgings for guns of 8-inch, 10-inch and 12-inch caliber prior to September 22, 1888—the date of the fortifications act—were those paid by the Navy Department under a contract with the Bethlehem Iron Company, dated May 1, 1887 (see letter of the Secretary of the Navy to the Secretary of War, dated October 27, 1888), of which the following is a résumé:

	Weight.	Price per ton.	Total price.
Forgings for 8-inch caliber.	*Tons.*		
Tubes and jackets	31.804	$676.51	$21,515.72
Hoops	23.088	634.23	14,643.10
Trunnion-hoop	2.964	634.22	1,879.83
Breech mechanism	.996	634.25	631.71
Total (131,828 pounds); at an average of 29⅓ cents per pound.	58.852	....	38,670.36
Forgings for 10-inch caliber.			
Tubes and jackets	426.888	$718.79	$306,842.83
Hoops	330.024	718.78	237,214.65
Breech mechanism	13.488	634.25	8,554.76
Total (1,725,696 pounds); at an average of 82 cents per pound.	770.400	....	552,612.24
Forgings for 12-inch caliber.			
Tubes and jackets	59.470	$761.07	$45,260.83
Hoops	49.796	718.79	35,792.87
Breech mechanism	1.596	634.25	1,012.26
Total (248,331 pounds); at an average of 33 cents per pound.	110.862	....	82,065.96

It is understood that the Bethlehem Iron Company expects to complete the deliveries of the different sets of forgings within the shortest times specified in its contract; accordingly the deliveries will be as follows:

	8-inch guns.	10-inch guns.	12-inch guns.
	Sets.	*Sets.*	*Sets.*
May 1, 1890	1		
May 1, 1891	18	1	
July 1, 1891	4		
August 1, 1891			1
May 1, 1892		12	
August 1, 1892			6
April 1, 1893		11	
December 1, 1893			8
Total	23	24	15

Work on the 8-inch forgings has been commenced.

12-inch B. L. mortars, hooped.

Cast-iron bodies.—Bid of the Builders Iron Foundry, Providence, R. I.

For twenty-nine rough turned and bored cast-iron bodies, of American manufacture, conforming to drawings and specifications attached, $1,475 each. The first body to be delivered within eight weeks from date of contract, and the whole contract to be completed within one year from date of contract.

The company is required by its contract to furnish such limited number of additional bodies at the price above stated as the Department may desire; and in default of delivery at the times specified shall pay a penalty of $1 per diem for each day of delay. As some unforeseen causes of delay were encountered at the outset of the work, the date of first delivery under the contract was extended to May 28, 1889, or about two months, as it was apparent that no injury would thereby result to the United States, since a number of the bodies would be completed before the first set of steel forgings was received.

The number of mortar bodies has been increased to thirty, and all should be completed by August 15, 1890. At this date fourteen bodies have been cast, and the tests, so far as made, show the metal to be fully up to the contract requirements.

Steel hoops and breech mechanism forgings.—Bid of the Midvale Steel Company, Nicetown, Pa.

For 29 sets of steel forgings, of American manufacture, for trunnion hoops, hoops and breech mechanism for 12-inch B. L. mortars, in accordance with drawings and specifications attached, $2,770 per set. The first set to be delivered in one hundred and twenty days from date of contract; the next 6 sets at the rate of 1 set every forty days thereafter, and the remaining 22 sets at the rate of 1 set every twenty days, the whole to be delivered within seven hundred and sixty days from the date of contract.

The cost of the forgings is about 19 cents per pound.

By the terms of this contract the Midvale Steel Company is subject to a penalty of $1 per diem for each day's delay in delivering at the time specified therein.

The number of sets of forgings has been increased to 30, and the deliveries should be completed by March 6, 1891. At this date 2 complete sets have been delivered and a considerable number of parts of sets has been completed.

Finishing and assembling.—The bids for finishing and assembling these mortars, received under the Department's advertisement of November 14, 1888, were considered to be excessive, and all were rejected. Under date of June 22, 1889, the Department issued a fresh advertisement for bids, which were opened on July 22, 1889, and the lowest bid (that of the Builders Iron Foundry) was accepted as satisfactory.

Bid of the Builders Iron Foundry, Providence, R. I.:

> For finishing and assembling twenty-nine 12-inch B. L. rifled mortars, more or less, in accordance with drawings and specifications attached, the principal parts therefor to be supplied by the United States, $3,725 for each finished mortar. The first mortar to be completed within six months after the receipt of the parts for it to be supplied by the United States, and the remaining twenty-eight to be completed thereafter at the rate of about one mortar every four weeks, provided the parts to be supplied by the United States shall have been received at least six months previous to the completion of each, and to complete all the mortars within two years and eight months from the date of contract.

A penalty of $1 per diem for each day's delay in delivering is embodied in the contract with this company. The number of mortars was increased to thirty and the date of the contract is August 19, 1889, so that if no delay occurs under the contract for furnishing the cast-iron bodies or for the steel forgings, thirteen of these mortars should be completed by March, 1891, twelve more by March, 1892, and the entire thirty by the 1st of August, 1892. It will be seen that the total cost of each mortar is $7,970. The estimate submitted by the Department to the Appropriations Committee was from $8,000 to $8,500 per mortar.

THE ARMY GUN-FACTORY.

In order to best meet the requirements of section 4 of the act of September 22, 1888, relative to the erection of an Army gun-factory at the Watervliet Arsenal, West Troy, N. Y., on the recommendation of the Chief of Ordnance, the Secretary of War appointed a board of ordnance officers to convene at that arsenal on October 4, 1888, to prepare the necessary plans and specifications, by the following special order (S. O. No. 228, A. G. O., 1888—extract):

> 9. By direction of the Secretary of War a board of ordnance officers, to consist of Col. James M. Whittemore, Lieut. Col. Francis H. Parker,* Capt. Charles Shaler, Capt. Charles C. Morrison,* and First Lieut. William B. Gordon, is hereby appointed to meet at the Watervliet Arsenal, West Troy, N. Y., on the 4th of October, 1888, or as soon thereafter as practicable, for the purpose of preparing plans, specifications, and

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*Owing to a change in their duties Lieutenant Colonel Parker and Captain Morrison were relieved from duty with this board by S. O. 39, A. G. O., February 15, 1889, and Col. A. R. Buffington, Ordnance Department, U. S. Army, and Mr. Anthony Victorin, engineer in the employ of the Ordnance Department, were detailed as members in their places.

estimates "for the erection, purchase, or manufacture of the necessary buildings and other structures, machinery, tools, and fixtures for an Army gun-factory for finishing and assembling heavy ordnance, to be erected at the Watervliet Arsenal, West Troy, New York," as authorized in the "act making appropriations for fortifications and other works of defense, for the armament thereof, for the procurement of heavy ordnance for trial and service, and for other purposes," approved September 22, 1888, and for the consideration of such other matters in connection therewith as may be properly brought before it.

The board will be guided by special instructions to be given by the Chief of Ordnance, and a committee of the board will visit such manufacturing or other establishments in the United States as may be deemed necessary by the Chief of Ordnance to acquire the information needed for its purpose. Upon the completion of the duty contemplated the members of the board will rejoin their proper stations. The travel enjoined is necessary for the public service.

The preliminary report of this board, with estimates for shop building and officers' quarters, was received on November 2, and referred to the Board of Ordnance and Fortification, and by them approved November 6 and 8.

CONTRACTS AWARDED.

Under act of September 22, 1888.

Advertisements were published under date of November 22, inviting proposals for making the necessary excavations for the gun-factory building, and for the erection of two sets of officers' quarters. The bids for this work were opened on December 24, 1888.

To Elnathan Sweet, of Albany, N. Y.:

For preparing site and making excavations for foundations for gun-factory	$11,692
Railway-track scale and turn-table	3,300

This contract was completed July 20, 1889.

As the bids for the two sets of officers' quarters exceeded the amount appropriated for their erection, the plans were modified and fresh bids invited, resulting in an award to Edward Kelly, of Troy, N. Y., who, under date of May 9, 1889, executed a contract as follows:

For erection of two sets of officers' quarters	$18,987

The time specified for completing this contract is November 1, 1889.

The detailed drawings and specifications for the gun-factory building having been completed and approved, bids were invited by advertisement under date of February 27, 1889, and opened April 2, 1889. Contracts were awarded as follows:

Charles Duncan, Troy, N. Y., wood-work	$24,600
Contract to be completed December 1, 1889.	
Stanton & Neary, Cohoes, N. Y., stone, brick masonry, and concrete.	54,500
Contract to be completed September 1, 1889; contract extended to November 1, 1889.	
Richard F. Hawkins, Springfield, Mass., iron-work	49,949
Contract to be completed October 1, 1889.	
F. F. Brewer, Syracuse, N. Y., slate-roofing, etc	13,700
Contract to be completed December 1, 1889.	
Martin Hunt, Troy, N. Y., cut stone	13,300
Contract to be completed August 1, 1889; contract extended to September 14, 1889.	
Total value of above contracts	171,041

A contract was also awarded the Morgan Engineering Company, Alliance, Ohio, under date of June 13, 1889, as follows:

For shaft and erection of traveling cranes	$11,995

This contract is to be completed by November 15, 1889.

Miscellaneous expenditures in connection with the erection of the gun-factory:

For services of constructing engineer and architect, draughtsmen, draughtsman's materials, surveys, printing advertisements and specifications, laying water-pipes, and sewers, for masonry and earthworks, for tools and implements, iron pipes, cement, etc	$27,722

Under act of October 2, 1888.

The bids for constructing a railroad line in the arsenal grounds, for building an iron bridge over the canal, etc., as provided for in the act making appropriations for the sundry civil expenses of the Government and for other purposes, approved October 2, 1888, were opened on December 24, 1888.

The contract awarded was as follows:

To Elnathan Sweet, Albany, N. Y.:

For construction of railroad line through grounds of Watervliet Arsenal	$8,430
For an iron bridge over the Erie Canal at Watervliet Arsenal, of 130 tons capacity, including abutments, etc	14,778

This contract was completed July 20, 1889.

A contract was made with the Morgan Engineering Company, Alliance, Ohio, under date of January 3, 1889:

For two overhead cranes of 30 tons capacity	$23,670
For one hand-power pillar crane	2,975

The other items specified in the act of October 2, 1888, are—

For crab, blocks, etc., for shrinkage pit	$4,350
For new machinery for present plant and for two steam-boilers, etc., which items have been procured in accordance with the law	13,000

With the money appropriated for the purpose, there will be erected the north wing of the gun-factory, adapted to the manufacture of 8-inch, 10-inch and 12-inch guns, and the center building containing the shrinkage plant, and probably a sufficient number of machines will be procured to turn out ten 8-inch guns, six 10-inch guns and four 12-inch guns per annum. The shop itself has sufficient capacity for an annual output of twelve 8-inch guns, seven 10-inch guns and five 12-inch guns, but the appropriation is not sufficient to purchase the requisite tools for this increased number of guns.

The long period of wet weather experienced during the past season has delayed to some extent the work on the gun-factory, and in one or two instances short extensions on contracts have been granted. But on the whole the work has progressed very satisfactorily, and it is expected that the roof will be on by the close of the present year, and that the smaller machine tools and fixtures will be set up in the building early in the coming year.

Machine tools.

Under date of August 5, 1889, the Department issued an advertisement for bids for supplying the smaller machine tools for the gun-factory, such as hoop-lathes, boring-mills, planers, shapers, drills, milling and grinding machines, etc. The instructions to bidders contained the following proviso:

> As it is intended to invite the widest possible competition consistent with thorough workmanship and correct designs, the following is made a part of the general specifications for machine tools required by the Ordnance Department for the gun-factory at Watervliet Arsenal, and referred to under newspaper advertisement dated August 5, 1889.
>
> If any reliable manufacturer or bidder can show to the satisfaction of the Department that the machines upon which he bids are equal or superior to similar machines covered by these specifications, though differing therefrom in particulars which may be deemed unessential, or immaterial as regards fitness for the performance of the particular work for which the said machines are intended, his bid will be received and duly considered in making the awards.

The bids were opened on the 5th of September, 1889, most of the prominent machine tool works of the country being represented, and the results, as regards construction of the machines, fitness for their purpose and the cost, were very satisfactory.

Contracts were awarded to the following manufacturers and for the amounts noted:

Bement, Miles & Co., Philadelphia, Pa	$33,370.00
Niles Tool Works, Hamilton, Ohio	72,455.00
Gould & Eberhardt, Newark, N. J	4,570.00
Brown and Sharpe Manufacturing Company, Providence, R. I	3,600.00
Fitchburg Machine Works, Fitchburg, Mass	6,520.00
Bridgeport Machine Tool Works, Bridgeport, Conn	3,200.00
William H. Warren, Worcester, Mass	7,550.00
William Sellers & Co., Philadelphia, Pa	1,520.00
James W. Soper, New York City	271.25
Forsaith Machine Company, Manchester, N. H	59.00
Purchased for immediate use: One universal milling machine	1,139.00
Total	134,254.25

The aggregate amount is substantially the same as the preliminary estimate of the Department. Some of these machines will be delivered at once, and all will be delivered during the coming winter, or before the 1st of March, 1890.

Large boring and turning lathes, engines, etc.

The drawings and specifications for the large lathes required for boring and turning guns are completed, and those for the rifling and breech-screw machines nearly so, and bids will be invited for supplying them at an early date.

It is expected that these large machines will be procured and set up in the shop by January, 1891. It is estimated that the lots of 8-inch, 10-inch, and 12-inch guns, the forgings for which are to be supplied under the contract with the Bethlehem Iron Company, will be completed as follows:

	Steel guns, completed.		
	8-inch B. L.	10-inch B. L.	12-inch B. L.
August, 1891	1		
November, 1891	5		
March, 1892		1	
November, 1892	10	5	1
June, 1893	7		
June, 1894		15	
October, 1894		3	8
July, 1895			6
Total	23	24	15

This estimate is based on the supposition that the steel forgings will be delivered within the shortest times specified in the contract therefor, and that a sufficient supply of machine tools will be procured from the appropriation for the gun-factory to turn out the number of 8-inch, 10-inch, and 12-inch finished guns per annum above noted.

The total amount thus far expended from the appropriation of $700,000 for the gun-factory, including what may be due under contracts not yet completed, is $364,000, which leaves now available for the above machines, and for completing the equipment of the shops $336,000.

COMPLETION OF GUNS UNDER MANUFACTURE, ETC.

Under section 3 of the act approved September 22, 1888, allotments were made by the Board, on the recommendation of the Department, agreeing with the items that had been submitted by the Department to the committees on appropriations. These items cover the completion and test of guns under manufacture by the Department, the manufacture of a type 12-inch B. L. rifle, steel; a type 10-inch B. L. rifle, steel, wire-wrapped; the manufacture and test of a 3.6-inch steel B. L. field gun; the test of a 5-inch siege B. L. rifle and a 7-inch siege B. L. howitzer, both of steel; the procurement of two types of carriage for the 12-inch B. L. mortar; a carriage for a 12-inch B. L. rifle to be mounted on a gun lift; for powders and projectiles for issue and for tests; for the alterations of carriages; for expenses of the proving ground; for draughtsmen employed in the Ordnance Office on gun construction, and an item of $10,000 for increased facilities for the manufacture of projectiles at the Watervliet Arsenal. Allotments were also made for the manufacture of one disappearing carriage for a 10-inch B. L. rifle, to be maneuvered by power; and for the completion and test of a Woodbridge 10-inch wire-wrapped B. L. rifle.

With respect to the more important of the foregoing items, the following progress has been made: The forgings for the tube, jacket and trunnion hoop for the type 12-inch B. L. rifle were ordered from the Creusot Works in France, and the hoops and other forgings from the Midvale Steel Works, at Nicetown, Pa. These forgings have all been delivered at the Watervliet Arsenal, where the gun is now under manufacture. The tube for the 10-inch wire-wrapped gun, on the design submitted by the Department, has also been delivered by the Creusot Works. The procurement of the wire is still under negotiation, as the award of a contract awaits the results of certain tests of samples submitted. The sum of $45,000 was allotted for type carriages, which was sufficient to procure from abroad the two 12-inch mortar carriages and one gun lift carriage for a 12-inch gun. Of the mortar-carriages, one was ordered from Messrs. Easton & Anderson, proprietors of the Erith Iron Works, Kent, England, and the other from Sir Joseph Whitworth & Co., Manchester, England. The first was to be completed by October 1, and the last about November 1, 1889. The foundations for these carriages are now being laid, and it is expected that the trials will take place the last of the year. The 12-inch gun-carriage is a gravity return carriage, to be maneuvered by hand power. It is designed for a hydraulic gun lift, upon which it is to be placed, and thus enabled to fulfill all the requirements for a disappearing carriage. This carriage is being manufactured at Le Creusot, France, and will be completed in about ten months. The type 12-inch B. L. rifle will be mounted on it for test.

The Department has procured the forgings for a 3.6-inch B. L. field gun and a 3.6-inch B. L. field mortar, and both these pieces are now under manufacture at the gun-factory Watervliet Arsenal.

The 8-inch B. L. rifle, steel, has been completed and will soon be mounted for test. This is the first gun of 8-inch caliber that has thus far been made in this country entirely of American steel. It has a length of bore of 32 calibers, weighs 14¼ tons, and embodies some original features in its breech mechanism. The 10-inch B. L. rifle, steel, is nearly completed and will be ready for test the coming winter. Samples of powder for the preliminary firings of these guns have been procured from the German manufacturers of brown powder.

With the $10,000 allotted for increased facilities for manufacturing projectiles, a small plant has been established at the Watervliet Arsenal—utilizing for the purpose the iron store-house at that post. An air furnace and a cupola furnace have been erected, and the manufacture of field, siege, and sea-coast projectiles has been commenced.

The sum of $45,000 was allotted for the alterations of carriages at Watertown Arsenal, which was sufficient to cover the alteration of about eighteen 8-inch M. L. converted rifle barbette carriages.

A contract has been awarded to the "Pneumatic Gun Carriage and Power Company" for one disappearing carriage for a 10-inch B. L. rifle, to be maneuvered by power, for the sum of $48,000, and steps are being taken for the manufacture of the Woodbridge 10-inch B. L. wire-wrapped gun. For the manufacture of this gun the Board allotted $20,000, and for its test $25,000. It was recommended by the Board that the gun be made by contract, and the Department accordingly issued a call for bids under date of July 12, 1889, but as no bids were received, on the further recommendation of the Board fresh bids were invited under date of September 30, 1889, with amended specifications, which will be opened October 30, 1889. The Department has also invited bids for some trial lots of armor-piercing 8-inch steel shot, and has accepted a bid from the Midvale Steel Company thereunder.

Some ballistic instruments of improved pattern have been ordered from abroad for use in determining the pressures in the bores of guns, and the resistance of hydraulic brakes; also several varieties of telescopic sights for guns have been ordered for trial.

Under that portion of section 3 that pertains to experiments with high explosives, the Department has ordered from the Nobel Company a quantity of explosive gelatine for the use of the Board, and has recently opened bids for the supply of a lot of 7-inch and 11-inch steel shell, also for the use of the Board in testing various designs for throwing high explosives in shell from powder-guns. Negotiations are also pending for the procurement of a supply of gun-cotton and detonating fuzes for experimental firings, with the 12-inch B. L. mortars, of shell charged with this explosive.

Section 6 of the act approved September 22, 1888, contains the following provision:

> The Board is authorized to make all needful and proper purchases, investigation, experiments, and tests, to ascertain with a view to the utilization by the Government, the most effective guns, including multicharge guns and the conversion of Parrott and other guns on hand, small-arms, cartridges, projectiles, fuzes, explosives, torpedoes, armor-plates, and other implements and engines of war; and the Secretary of War is hereby authorized to purchase or cause to be manufactured, such guns, carriages, armor-plates, and other war materials and articles as may, in the judgment of said Board, be necessary in the proper discharge of the duty herein devolved upon them: *Provided*, That the amount expended and liabilities incurred in such purchases, investigations, experiments, and tests shall not exceed five hundred thousand dollars which sum is hereby appropriated: *Provided further*, That said Board shall test, and if found satisfactory, shall purchase two breech-loading field guns of three and two-tenths inch bore, of aluminum bronze.

From the above item of $500,000 the Board has allotted $15,000 for the working drawings, manufacture and mounting of a King disappearing carriage for a 10-inch gun, and on recommendation of the Department $3,870 has been allotted for the purchase of a 6-pounder rapid-fire gun on the Driggs system, with 500 rounds of ammunition. The Department has also recommended for allotment under this section the manufacture of a steel field gun, fitted with the Driggs breech mechanism and adapted to the use of metallic cartridges, with the object of securing greater uniformity from the powder by the use of air-tight cartridge cases. It is thought inexpedient to combine the projectile with the cartridge, as owing to the size and weight of the ammunition it would be likely to break up when subjected to the rough usage of transport in the ammunition chests of the field carriages. Under this section a further allotment of $15,000 has been made for experiments with high explosives.

The Board has also allotted $600 for the purchase of a Martini-Henry rifle, Hurst's modification, with 500 rounds of ammunition; and $18,000 for the purchase of an 8-inch gun, on the Mefford system, provided the gun passes a satisfactory test.

FORTIFICATIONS ACT, APPROVED MARCH 2, 1889.

Under the act making appropriations for fortifications and other works of defense, for the armament thereof, and for other purposes, approved March 2, 1889, on the recommendation of the Department the Board of Ordnance and Fortification has made the following allotments:

For the test of experimental guns procured under the act of September 22, 1888, namely, for one 10-inch wire-wound gun, steel, $28,000; for one 12-inch gun, steel hooped, $39,500; for gun platforms at proving ground, $6,500; for projectiles for field, siege, and sea-coast guns for issue to the service, $28,500; for siege-gun powder for issue to the service, $7,000; for fuzes and implements for issue to the service, $2,000; in all, $125,000.

For the alteration of barbette carriages for 10-inch smooth-bore guns to adapt them to the service of 8-inch muzzle-loading converted rifles, $54,000; for the alteration of barbette carriages for 15-inch smooth-bore guns to adapt them to present service conditions, $46,000; in all, $100,000.

For the manufacture of 40 caissons and 10 combined battery wagons and forges for 3.2-inch field guns, $43,274.

For procuring the necessary instruments and other materials and for the proper installation of instruments for conducting the annual heavy artillery practice of the Army, $20,000.

For repairs and improvements at the Ordnance Proving Ground, Sandy Hook, N. J., namely: Repairing dock and dredging, $5,500; relaying roads and walks, $3,800; repairs to officers' quarters, $2,000; repairs to foreman's and soldiers' quarters, $2,600; repairs to office, $500; repairs to shops and store-houses, $1,000; machinery for shops, $4,000; clearing ground about ranges, $600; laying narrow-gauge tramway to proof butts and targets, $5,320; in all, $25,320.

The various supplies above noted are being manufactured or steps are being taken for their procurement, all of which, under the terms of the law, are to be of American manufacture. The repairs and improvements at the Ordnance Proving Ground, Sandy Hook, are well under way. The allotment of $100,000 for alteration of carriages will cover about twenty-nine 8-inch converted rifle barbette carriages and ten 15-inch barbette carriages, and the work is in hand at the Watertown Arsenal.

Four caissons and a combined battery wagon and forge were manufactured in advance of the rest, and issued to one of the light batteries that took part in the field exercises at Mount Gretna, Pa., during the past summer, in order to subject the new material to a test assimilating that of actual service as nearly as practicable, and thus to ascertain any modifications were desirable. Some minor defects were developed by these trials, but were such as may be easily remedied in further construction.

For the remaining items appropriated under this act, the Department will submit its recommendations to the Board later in the year, as before doing so it will await the delivery of gun forgings and the completion and test of certain experimental guns and carriages. The design for a disappearing gun carriage for a 10-inch gun will be ready for submission by about next December. These remaining items are as follows:

For the finishing and assembling of 8-inch, 10-inch, and 12-inch steel guns made from forgings procured under the act of September 22, 1888, $35,000.

For the purchase of steel forgings for field and siege cannon, as follows:

For steel forgings for not less than twenty-four 3.6-inch field guns, $24,000;

For steel forgings for not less than ten 5-inch siege guns, $20,000;

For steel forgings for not less than ten 7-inch siege howitzers, $18,000;

For steel forgings for not less than sixteen 3.6-inch field mortars, $2,000;

For the manufacture of field and siege cannon (finishing and assembling) within the fiscal year 1890, $14,000; in all, $78,000;

For procuring one 10-inch disappearing gun-carriage, $13,500;

For the manufacture of carriages for 12-inch breech-loading rifled mortars, procured under the act of September 22, 1888, $100,000.

ESTIMATES FOR THE FISCAL YEAR 1890-'91.

In the annual estimates of the Department, under the head of armament, for the next fiscal year, the following are the principal items:

For machinery to complete the full capacity of the present gun-factory building at Watervliet Arsenal $60,000

This will enable the Department to procure sufficient additional machines to give the annual output of finished guns for which the shop was designed, viz, twelve 8-inch guns, six 10-inch guns, and five 12-inch guns.

To complete Army gun-factory building, by the erection of the south wing, inclusive of ways for traveling cranes $248,743

The wing now being erected is adapted to the manufacture of heavy guns of 8-inch, 10-inch, and 12-inch caliber.

The south wing will be adapted to the manufacture of guns of 12-inch and 16-inch caliber. The cost of this building proper, without the crane ways or cranes, will be about $182,743.

For machine tools and fixtures for south wing of Army gun-factory $888,570

This additional plant will suffice for an output of ten 12-inch guns and six 16-inch guns per annum.

For the manufacture of ten 12-inch guns alone per annum the necessary machines and fixtures would cost about $437,460.

The center building of the gun-factory now being erected will be adapted to the assembling of the guns made in both wings, or to guns from 8 inches to 16 inches caliber inclusive.

For the [illegible]re of 12-inch B. L. rifled mortars, cast-iron, hooped steel. $400,000

This sum should procure about fifty mortars, on the basis of the present contract, which makes the cost about $8,000 per mortar.

For mortar carriages.. $225,000

It is estimated that this sum, with the item of $100,000 appropriated last year for the same purpose, will procure about a sufficient number of carriages to mount the thirty mortars now under manufacture.

The type of carriage has not yet been decided on, but it is anticipated that one or both of the experimental mortar-carriages procured from abroad and soon to be tested will furnish the basis of a suitable carriage for adoption.

For the forgings for one type 16-inch B. L. gun.................................... $125,000

These forgings could be delivered probably by July, 1891, and by that time the finishing could be conducted in the present gun shop. To accomplish this the 120-inch lathe in present use would have to be lengthened, and an item of $10,000 has been included in the estimates. The assembling of tube and jacket would be performed in the new shops. Should Congress authorize the procurement of this set of forgings abroad, it is probable that the cost could be materially reduced.

For steel armor-piercing projectiles for sea-coast guns.......................... $200,000

It will require considerable time for any of our steel makers to make the necessary arrangements for the manufacture of projectiles of this class, and no time should be lost in holding out to them a sufficient encouragement. This item, with the sum of $200,000 that the Navy Department has already available for the same purpose, will go far towards meeting this end. The Department has included an estimate of $24,000 for the purchase and erection of armor plates—about four in number—for the test of those projectiles, and it will have an 8-inch and a 10-inch high-power steel gun available for the requisite tests. It is the purpose to procure only 8-inch and 10-inch armor-piercing projectiles with this appropriation, if made, as the 12-inch gun will not be completed in time for the test of 12-inch shot.

For steel shell for sea-coast cannon.. $25,000

These shell are required more particularly for experiments with gun-cotton or other high explosives, to be fired from 12-inch B. L. mortars or siege guns.

For finishing and assembling 8-inch, 10-inch and 12-inch guns from forgings procured under the act of September 22, 1888.................................. $70,000

This sum, with that appropriated last year—*i. e.*, $35,000—will probably be all that can be utilized prior to June 30, 1891.

For alterations of sea-coast carriages.. $100,000

This sum will suffice for the alteration of about fifteen 15-inch carriages and about twenty 10-inch carriages for use with the 8-inch M. L.

converted rifles. The total number of 15-inch carriages thus altered by June 30, 1890, will be 29, which this appropriation would increase by 15; total 44; and assuming that at least 100 of these carriages will be altered, there will still remain for alteration 56 carriages.

The total number of 10-inch carriages altered for use with 8-inch M. L. rifle by June 30, 1890, will be 97, which this appropriation would increase by 20; total, 117.

There are 210 of these 8-inch M. L. rifles, so that there will remain for alteration 93 carriages. This work will be done, as heretofore, at the Watertown Arsenal.

For metallic carriages for field-gun batteries $143,150

This sum will cover the manufacture of seventy-five steel field carriages, new light model, twenty-five limbers, twenty-five caissons, and six combined battery wagons and forges for the 3.2-inch horse-artillery gun, and twenty-four limbers, twenty-four caissons and six combined battery wagons and forges for the 3.6-inch field artillery gun. The fifty carriages already made for the 3.2-inch gun may be adapted, at a trifling cost, to the 3.6-inch gun, should the trial of the experimental 3.6-inch gun demonstrate that these carriages are strong enough, as it is believed they are.

For steel field guns of 3.2-inch caliber $25,000

This sum will procure twenty-five additional 3.2-inch field guns. There are required to equip the ten field batteries, and for the U. S. Military Academy, the Artillery School at Fort Monroe, Va., and the Proving Ground, about fifty-five field guns with their carriages, allowing each battery four guns with four horses for carriage, except the two batteries at Fort Riley and the Cadet Battery at the Military Academy, which may have six guns with four or six horses per carriage.

Fifty 3.2-inch guns have thus far been made and 25 more are under manufacture. Of the completed guns 16 have been issued to the light batteries of the Army, 4 to each battery; 12 are about ready for issue to the two batteries at the light-battery school at Fort Riley, Kansas, when required; 2 guns have been issued to the Military Academy; 2 guns to the artillery school at Fort Monroe; 1 gun to the proving ground, Sandy Hook; 1 gun to the Washington Barracks, and 4 guns to the State of Vermont.

The 50 caissons and 12 combined battery wagons and forges will be completed this present year; but some delay in arming the batteries with new material will result from the want of a sufficient appropriation from which to procure the necessary harness. Including the guns now under fabrication, the Department will have, when all are completed, about 16 3.2-inch guns for issue to the militia during the coming year.

The estimates also contain an item of $5,000 for machinery and plant for the manufacture of steel shrapnel for field guns.

TESTS OF GUNS.

During the past year the experimental work at the proving ground has been retarded by bad weather and the necessity for making repairs and increasing the facilities for carrying on the work.

The instrument house which contained all the ballistic instruments, pressure gauges, and all the records of tests was completely destroyed with its contents by lightning.

There has also been much delay in procuring powders that filled the contract requirements. Up to date the 8-inch B. L. gun has been fired 264 rounds and the test will be completed up to 300 rounds* probably during the present month. The gun is in a good and sound condition, but is considerably eroded in the shot chamber and for a length of bore of about a caliber and a half in front of the origin of the rifling. It is thought, however, that neither its accuracy of fire nor its endurance is thus far materially affected by the erosion.

The 12-inch B. L. mortar has been fired to date 227 rounds. Charges have been used in the test of this piece up to 82 pounds, giving a muzzle velocity of about 1,200 feet, with a pressure of about 31,000 pounds per square inch on the chamber, and the piece has been subjected to even higher pressures. In view, however, of the relative weakness of the cast-iron body, it is the intention to limit the maximum service charge for this piece to 80 pounds of R. H. brown prismatic powder, which corresponds to a velocity of about 1,152 feet for a shell of 630 pounds with a pressure of 28,000 pounds per square inch on the powder chamber. A range has been attained with this charge and weight of shell, under an angle of 45°, of 10,480 yards, or 5.95 miles; the muzzle energy is 5,796 foot-tons. It is the intention to subject the mortar to a test of endurance of not less than 400 rounds, of which 200 shall be with the maximum charge, or in which the pressure shall be the maximum of 28,000 pounds per square inch. Further firing will be postponed, however, until the new type carriages are received, as it is desired to test these carriages at the same time as the mortars for economical reasons. Besides, the old platform and carriage have become so much deranged that it is impracticable to make satisfactory firings for accuracy from them.

The 5-inch B. L. steel siege rifle and the 7-inch B. L. steel siege howitzers have been turned over to the Board for Testing Rifled Cannon, and the test of these guns is now in hand. Some trials have been made with 3.2-inch shell of increased length, and experiments are in progress in working up a steel shrapnel with a combination time and percussion fuze for the field service.

The two 12-inch B. L. rifles—one cast-iron tubed with steel, and the other cast-iron hooped and tubed with steel—completed last year, and for the test of which provision was made in the act approved September 22, 1888, are now at the proving ground. The tubed gun is mounted, and the tests will be begun as soon as the gas check, now under manufacture, is received. A sufficient number of projectiles has been procured for the test of both guns; also some 34,000 pounds of brown prismatic powder. The additional powder required will be procured as soon as some preliminary firings have been made with the tubed gun. These guns will be tested under the supervision of the Board for Testing Rifled Cannon, etc.

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* Since writing the above the full number of 300 rounds has been completed.

The manufacture of the 10-inch B. L. rifle, cast-iron, wire-wrapped, is being completed at the Watervliet Arsenal. The Department has procured the projectiles for the test of this gun, and a sample of prismatic powder. The additional powder required can not be procured until after the sample has been tested. It is expected that the tests of all three of the above-described cast-iron guns will be completed during the coming year.

TESTS BY THE BOARD OF ORDNANCE AND FORTIFICATION.

Section 6 of the act approved September 22, 1888, provides as follows:

SEC. 6. Whenever any party shall present for test a completed cast-iron breech-loading mortar of 12 inches caliber, of about 32,000 pounds weight, with a proper supply of ammunition therefor, not exceeding 200 pounds, such mortar shall be tested in the presence of the party presenting the same, and should it be shown to the satisfaction of the Board by such tests to be equal in accuracy, range, power, endurance, material, and general efficiency to the 12-inch cast-iron steel-hooped breech-loading mortar now at Sandy Hook, the mortar and ammunition shall be paid for, including cost of transportation, and contract to be made for a further supply of not less than fifty, and not more than one hundred, at such reasonable cost as the Board herein provided for shall determine, not to exceed $6,500 each. The entire number to be delivered in one year from date of contract. Said mortar and all which may be contracted for under this provision shall be subject to inspection at each stage of manufacture.

Whenever any party shall present for test a completed single-charge breech-loading steel gun of 10 or 12 inches caliber, and of weight and dimensions to be prescribed by the Board with the proper supply of ammunition for the test of the same, such gun shall, in the presence of the party presenting it, be subjected to such tests as the Board shall have prescribed; and should such gun be shown to the satisfaction of the Board by such tests to fulfill the requirements previously prescribed in respect to accuracy, range, power, endurance, and general efficiency, the gun and ammunition shall be paid for at a fair valuation, including cost of transportation, and contract shall be made at a price reasonable in the opinion of the Board, with the party presenting the best of such guns, for a further supply of similar guns, to be subjected to the usual service test before acceptance, the experimental guns and all guns purchased hereunder to be subject to inspection at each stage of manufacture, as follows, namely: For not less than fifty 10-inch steel guns; and for not less than fifty 12-inch steel guns

* * * * * * *

That under the provisions of this section there shall not be expended or contract or contracts entered into involving the Government in an aggregate expenditure exceeding $6,500,000, nor an expenditure on the part of the Government in any one fiscal year in excess of $2,500,000, and all guns and materials purchased under authority of this section shall be of American production and furnished by citizens of the United States.

* * * * * *

Under the above provisions the South Boston Iron Works submitted to the Board a 12-inch B. L. cast-iron mortar, with ammunition therefor, for test. The form and dimensions of the bore, chamber and breech mechanism of this mortar, and the projectiles therefor, conform to the designs of the Ordnance Department for the 12-inch B. L. mortar, cast-iron, hooped with steel. The maximum diameter of the finished cast-iron mortar was 43.5″, and its weight 14.85 tons, as against 41.75″ maximum diameter and weight of 14¼ tons for the hooped mortar. The Board prepared a programme for the test of this cast-iron mortar, which was substantially a duplicate—as regards weights of charge and projectile, kind of powder, velocity and pressure—of the firings thus far made with the 12-inch B. L. mortar, hooped, referred to in the act of September 22, 1888, and with a restriction, based also on the firings with the hooped mortar, that the rapidity of fire should not exceed 15 rounds per day. This programme was approved by the Secretary of War and referred to the Department for execution.

The trials began on October 3, and were continued on October 4 and 5, in the presence of members of the Board and the representatives of the South Boston Iron Works. At the twentieth round the mortar burst, explosively, into a number of fragments, which were thrown off with great violence. No other damage was done beyond the demolition of the mortar and its carriage, as the precaution had been taken to surround the mortar with high and heavy traverses of sand bags.

A copy of the firing records, with full description of the trials, accompanied by photographs, will be submitted by the Department to the Secretary of War at an early date for reference to the Board of Ordnance and Fortification.

PNEUMATIC DYNAMITE GUNS.

The act making appropriations for the support of the Army for the fiscal year ending June 30, 1889, and for other purposes, approved September 22, 1888, contains the following:

> For the purchase by the Secretary of War of pneumatic dynamite guns of different calibers, and the necessary machinery to fire and handle the same, ammunition and carriages for the same, all complete and mounted in place ready for military use, $400,000, or so much thereof as he may deem proper.

The act of the same title for the present fiscal year, approved March 2, 1889, provides for the procurement of an additional number of these guns, as follows:

> For the purchase by the Secretary of War of three pneumatic dynamite guns of 15-inch caliber, and the necessary machinery to fire and handle the same, ammunition and carriages for the same, to be placed and mounted ready for use, free of cost to the Government, at such point or points on the Pacific coast as may be designated by the Secretary of War, $187,500, or so much thereof as he may deem proper.

Pursuant to these acts contracts have been made with the Pneumatic Dynamite Gun Company of New York. The first, dated March 6, 1889, provides for the erection of one 8-inch and six 15-inch pneumatic dynamite guns to be supplied with ten projectiles each. These guns are to be mounted in the defenses of the ports of New York and Boston. This contract, by original agreement, would expire November 6, 1889, but has been extended to May 6, 1890. The second contract, dated June 10, 1889, extends to June 10, 1890. It provides for the erection of three 15-inch pneumatic dynamite guns to be supplied with ten projectiles each. These guns are to be mounted in the defenses of the port of San Francisco.

The contracts stipulate that the guns shall be delivered to the Government, with their carriages and projectiles and the necessary machinery, appurtenances and accessories properly and securely placed to fire, handle, and operate the guns, all complete and mounted in place ready for military use, the guns and carriages to be supplied with secure and adequate foundations, so as to stand without any derangement the continuous fire of the heaviest projectiles to be used. Besides the gun carriages, the machinery and accessories with these guns comprises a duplicate plant of steam-boilers, air compressors, and storage reservoirs for holding the compressed air, with hydraulic pumps and suitable pipe connections and machinery. The rate of firing is to be at least once in three minutes for each gun using a projectile charged with 500 pounds of explosive gelatine or an equivalent bulk of other high explosive, and twice that rate of speed for a projectile charged with 100 pounds of the explosive.

The projectiles for the 8-inch gun comprise two classes, one of full caliber, carrying a charge of 100 pounds, the other, a subcaliber projectile, carrying a charge of 50 pounds of the explosive. The projectiles for the 15-inch guns comprise four classes, namely, a full caliber projectile carrying 500 pounds, and three subcaliber projectiles, 6-inch, 8-inch, and 10-inch diameter, carrying, respectively, 50, 100, and 200 pounds of the explosive. The 8-inch gun must be capable of projecting shell charged with 100 pounds of the explosive to all ranges from 100 yards to 2,600 yards, and shell charged with 50 pounds of the explosive to all ranges from 100 yards to 3,200 yards. The 15-inch gun of 32-calibers length of bore must be capable of projecting shell to the following ranges with the charges of explosive noted, namely: From 100 to 1,760 yards, a shell containing 500 pounds of the explosive; 100 to 3,000 yards, 200 pounds; 100 to 4,000 yards, 100 pounds; 100 to 5,000 yards, 50 pounds.

With a 15-inch gun of 40 calibers length of bore the said ranges to be increased to the following, namely: 2,000, 3,550, 4,500, and 5,500 yards, without diminution of the stated charges. For the 15-inch guns an allowable deficiency not to exceed 10 per cent. of the ranges stated will be admitted.

Taking a standard rectangle 360 feet in length by 90 in width as the horizontal target, the accuracy of fire for all the guns must at least fulfill the following requirements: 87 per cent. of hits at 1,000, 74 per cent. at 2,000, 61 per cent. at 3,000, 47 per cent. at 4,000, and 35 per cent. at 5,000 yards. These requirements as to range and accuracy are to be established by firing tests of the guns preliminary to their acceptance by the Government.

The cost of the guns tested and delivered in place ready for military use at sites specified in the contracts is as follows: One group, comprising one 8-inch and two 15-inch guns, $155,935; two groups, each comprising two 15-inch guns, $109,435 per group, $218,870; one group, comprising three 15-inch guns, $176,000. The aggregate cost of one hundred (100) projectiles, delivered ready in all respects to be charged for service, is $36,000. This number includes the several classes of projectiles to be procured, viz: 8-inch for 50 pounds charge, $200 per shell, and for 100 pounds charge $250 per shell; 15-inch for charges of 100, 200, and 500 pounds, respectively, $250, $350, and $500 per shell. These prices are exclusive of the explosive charge.

No appropriation has yet been made to provide permanent fortifications for these guns. The specifications accompanying the outstanding contracts mentioned are printed in full in an appendix to this report.

I have also the honor to submit herewith the following papers:

Appendix 1.—Statement of principal articles procured by fabrication during the year ended June 30, 1889.

Appendix 2.—Statement of principal articles procured by purchase during the year ended June 30, 1889.

Appendix 3.—Statement of ordnance, ordnance stores, etc., issued to the military establishment, including the national homes for soldiers of the volunteer and regular Army, and exclusive of the militia, during the year ended June 30, 1889.

Appendix 4.—Statement of ordnance, ordnance stores, etc., distributed to the militia from July 1, 1888, to June 30, 1889, under section 1667, Revised Statutes.

Appendix 5.—Statement of ordnance, ordnance stores, etc., distributed to colleges from July 1, 1888, to June 30, 1889, under section 1225, Revised Statutes.

Appendix 6.—Statement of arms and ammunition issued to the Executive Departments during the year ended June 30, 1889, under the provisions of the act of March 3, 1879.

Appendix 7.—Report of action taken during the year ended June 30, 1889, under the provisions of the act approved March 3, 1881.

Appendix 8.—Showing the stations and duties of the officers of the Ordnance Department.

Appendix 9.—Reports on making small purchases.

REPORTS FROM THE NATIONAL ARMORY.

Appendix 10.—Trial of a Rubin 7.5^{mm} repeating rifle. (2 plates.)

Appendix 11.—Trial of a Schulhof 7.5^{mm} repeating rifle. (2 plates.)

Appendix 12.—Trial of Smith & Wesson 0.38 caliber, hammerless safety revolver, double action, and Colt's 0.38 caliber revolvers, double action, new Navy pattern.

ORDNANCE CONSTRUCTION.

Appendix 13.—Modifications of design, 3.20-inch B. L. rifle, steel—I. Guns numbered 1 to 25, original series; II. Guns numbered 1 to 25, Watervliet Arsenal series.

Appendix 14.—Specifications for the fabrication, description, and nomenclature of 3.20-inch B. L. rifle, steel. (5 plates.)

Appendix 15.—Construction of fifty 3.20-inch field limbers, one caisson, and one combined battery wagon and forge. (3 plates.)

Appendix 16.—Progress report on manufacture of cast-iron bodies at Builders Iron Foundry for 12-inch B. L. steel hooped mortars.

Appendix 17.—Shrinkages, resistance, etc., of 12-inch B. L. rifled mortar, cast-iron, hooped with steel. (1 plate.)

Appendix 18.—Report on the manufacture of the Midvale steel forgings for gun construction.

Appendix 19.—Report on the manufacture of 12-inch B. L. rifle, cast-iron, steel-hooped and tubed.

BIDS, SPECIFICATIONS, AND CONTRACTS.

Appendix 20.—Forgings for 8-inch, 10-inch, and 12-inch guns, to be procured under the act of September 22, 1888. (6 plates.)

Appendix 21.—Forgings, cast-iron bodies, and manufacture of 12-inch B. L. rifled mortars, cast-iron, hooped with steel. (4 plates.)

Appendix 22.—Buildings for Army gun-factory, Watervliet Arsenal, West Troy, N. Y. (4 plates.)

Appendix 23.—Machine tools for Army gun-factory.

Appendix 24.—Pneumatic dynamite guns. (1 plate.)

Appendix 25.—Ten-inch disappearing pneumatic gun-carriage.

MISCELLANEOUS.

Appendix 26.—Report of principal operations at Rock Island Arsenal, Illinois. (12 plates.)

Appendix 26*a*.—Viaduct at Rock Island Arsenal.

Appendix 27.—Progress report of operations at Watervliet Arsenal in connection with erection of Army gun-factory.

Appendix 28.—Report of principal operations at U. S. Powder Depot, Dover, N. J.

Appendix 29.—Report of work on artesian well, Augusta Arsenal, Georgia.

Appendix 30.—Report of principal operations at Cheyenne Ordnance Depot, Department of the Platte.

Appendix 31.—Report on new work-shops at the National Armory. (11 plates.)

Appendix 32.—Report on the construction of battery at the New York State camp-ground, Peekskill, N. Y. (3 plates.)

Appendix 33.—Report on the construction of a 12-inch cast-iron mortar by the South Boston Iron Works under section 6 of the act of September 22, 1888. (1 plate.)

Appendix 34.—Analysis of reports on the "Morse" and service small-arm cartridges.

Appendix 35.—Report on location of Army gun-factory.

I have the honor to be, very respectfully, your obedient servant,

S. V. Benét,

Brig. Gen., Chief of Ordnance.

To the Hon. Secretary of War.

APPENDIX 1.

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tatement of principal articles procured by fabrication at the Arsenals during the fiscal year ended June 30, 1889.

CLASS II.

26	carriages, metallic, for 3.2-inch field guns.
20	carriages and limbers, metallic, for Gatling gun, caliber .45.
230	gun-carriages for Life-Saving Service.
1	caisson for 3.2-inch field gun.
51	limbers for 3.2-inch field carriages.
1	battery wagon and forge.
1	carriage, barbette, E. P. for 5-inch steel rifle and 7-inch steel howitzer.
2	carriages and chassis, barbette, for 8-inch rifle.

CLASS III.

2	buckets, sponge.
4	buckets, water.
12	buckets, watering.
10	breech covers.
24	fuse blocks.
2	fuse gimlets.
23	gun covers for Gatling gun.
50	gun mounts for Gatling gun.
4	handspikes.
70	sets artillery harness, for 2 wheel-horses.
75	sets artillery harness, for 2 lead-horses.
4	sets harness for Hotchkiss mountain gun.
1	set cart harness.
1	set harness, artillery store wagon, for 4 horses. (Experimental.)
10	muzzle covers.
24	muzzle or front sights.
8	priming wires.
230	quoins.
24	pendulum hausses.
4	sponge covers for 3-inch rifle.
2	sponge covers for 3.2-inch rifles.
8	sponge covers for 6-pounder gun.
2	sponge covers for 12-pounder mountain howitzer.
1	sponge and rammer for 3.2-inch rifle.
10	sponges and rammers for 6-pounder gun.

1	sponge and rammer for 12-pounder gun.
80	sponges and rammers for 3-inch rifled gun.
10	sponges and staves for Hotchkiss mountain gun.
118	thumbstalls.
5	tompions for 3-inch rifle.
3	tompions for 3.2-inch rifle.
1	tompion for 12-pounder gun.
3	tompions for 6-pounder gun.
21	rear sights, bronze, for 3.2-inch gun.
15	vent covers.
17	vent pieces.
24	wipers for mortar.
24	pouches for pendulum hausses.
1	sight-case for Gatling gun.
50	brakes for Buffington field-gun carriages.
2	bow-spring brakes for field-gun carriages.
2	pairs road brakes.
24	feed guides for Gatling gun.
101	screw-drivers for 3.2-inch rifles.
200	paulins, 12 by 15 feet.

CLASS IV.

600	5-inch shells for breech-loading steel rifle.
350	7-inch shells for breech-loading siege howitzer.
1,431	3.6-inch shells for breech-loading rifle.

CLASS V.

10	3.2-inch shrapnel, steel case.

CLASS VI.

5,000	Springfield carbines; caliber, .45; model, 1884.
2	Springfield carbines; caliber, .45; 24-inch barrel.
34,270	Springfield rifles; caliber, .45; model, 1884.
2,000	Springfield cadet rifles; caliber, .45; model, 1884.
325	officers' swords.
1	cavalry and field officer's saber.
50	light artillery officers' sabers.
650	knives for hospital corps.

CLASS VII.

ARTILLERY ACCOUTERMENTS.

249	knapsacks for light batteries.

CAVALRY EQUIPMENTS.

158	saber belts.
160	saber belt plates.
1,002	saber belts and plates.
2,000	pistol-holsters.
3,000	saber belts and plates with saber attachment.
2,002	saber knots.

INFANTRY EQUIPMENTS.

5,018	bayonet-scabbard bodies.
7,700	bayonet-scabbards.
200	blanket bags.
200	pairs blanket-bag shoulder-straps.
8,175	cartridge-boxes, McKeever.
400	cartridge-belts.
5,000	cartridge-belt plates.
10,000	canteens.
11,700	canteen-straps.
700	pairs coat-straps.
23	frogs, sliding.
18,627	gun-slings.
7,200	haversacks.
5,200	haversack-straps.
4,650	waist-belts.
5,102	waist-belt plates.
4,530	meat-cans.
37	gun-slings altered to conform to model 1887.
2,000	waist-belts and plates, without loops.
650	scabbards for hospital corps knives.
1	knapsack.
100	canteens, covered with dyed duck.

APPENDAGES.

17,602	headless shell-extractors.
6,613	screw-drivers, model 1879.
17,400	wiping-rods, wooden.
115	pistol grip screws.

HORSE-EQUIPMENTS FOR CAVALRY.

1,200	bridles, watering.
5,000	curry-combs.
3,220	halters and straps.
7,000	horse-brushes.
1,002	horse-covers.
1,000	links.
5,000	nose-bags.
1,000	saddles.
2,000	saddle-bags, leather.
20	side-lines.
1	guidon socket.
2,250	carbine boots and straps.
500	pairs spurs for mounted officers.
1,000	pairs spurs, cavalry.
2,000	pairs spur-straps.
4	housings for brigadier-general's saddle.
124	saddle-cloths, line officers.
31	saddle-cloths, staff officers.
200	saddle-cloths, hair.
1	pair sweat-leathers.
1	housing for major-general's saddle.

CLASS VIII.

22, 243	blank cartridges, 3-inch gun.
5, 202	blank cartridges, 6-pounder gun.
8, 141	blank cartridges, 12-pounder gun.
30	blank cartridges, 4.5-inch gun.
30	blank cartridges, 3.2-inch gun.
1, 715	blank cartridges, ½ pound charge.
6, 010	blank cartridges, 1 pound charge.
6, 379	blank cartridges, 1¾ pound charge.
4, 828, 365	rifle-ball cartridges, caliber .45, reloading.
213, 085	rifle and carbine blank cartridges, caliber .45, reloading.
210, 570	rifle and carbine blank cartridges, caliber .50.
852, 825	rifle-ball cartridges, caliber .45, brass shells, reloading.
3, 000	rifle-ball cartridges, caliber .45, "Morse."
930, 719	carbine-ball cartridges, caliber .45, reloading.
383, 936	revolver blank cartridges, caliber .45, reloading.
25	metallic fuze plugs, time.
124	combination fuzes, 3.2-inch projectiles.
800	base fuzes for 3.2-inch shells.
20	fuze plugs, wood, for 10-inch shells.
2, 503, 000	carbine bullets, caliber .45, 405 grains.
4, 695. 500	rifle bullets, caliber .45, 500 grains.
14, 600	round balls, caliber .45.
490, 000	revolver bullets, caliber .45.
142, 097	friction primers for cannon.
3, 100	electric primers for cannon.
501	friction primers, obturator.

CLASS IX.

20	rollers, long.
12	rollers, short.
8	platforms for mortars.
4	platforms for siege carriages.
14	marking outfits.
22, 000	marksman's buttons.
1, 500	sharpshooters' badges.
5	primer extracting tools.
245	dies, reloading.
5	primer inserting tools.
150	dies, resizing tool.
190	gaugers, resizing.
1	stand, resizing tool.
60	wiping-rods.
5	powder charging tools.
60	shell scrapers, "Morse."
6	tools, resizing.
3	rings, resizing tools.
6	assembling and crimping tools.
210	dies, upper.
50	dies, lower.
24	sets, supplemental tools, Morse.
3, 000	centers for paper targets.
49	marking staves and discs.
4, 500,000	pasters, black and white.

74	signal-flags.
130	streamers for rifle range.
20	targets, "Brinton."
30	targets, "Cushing."
294	targets, "Laidley," revolving.
87	targets, artillery.
31,000	targets, paper.
57	targets, truck, "Texas."
978	target-frames.

CLASS X.

1	trunnion cap-pin and washer, etc., Hotchkiss gun.
2	gas-check cups.
6	gas-check pads.
1	crank-spring, Gatling gun.
2	screw-studs, 3-inch rifle.
55	parts of field carriages.
3	parts of Laidley cavalry forges.
54	poles for field or siege carriages.
2	brake-rods, 5-inch siege carriage.
1	lunette prop.
1	pole prop.
2	retraction props.
73	assembling bolts.
100	linchpins, No. 1.
8	pole-prop straps.
12	parts of siege carriages.
6	parts of limbers.
6	reins, long.
35	collars.
50	halters, artillery.
6	wiping-rods, Gatling gun.
1	set of supports for telescopic sight, 3.2-inch gun.
72	trace-chains.
54	rammer-heads for 3-inch guns.
162	sponges for 3-inch rifled guns.
6	sponges for 6-pounder guns.
14	sponges for 12 pounder guns.
6	sponges for 12-pounder mountain howitzer.
10	sponges, woolen, for 3.2-inch rifle.
4	staves for light 12-pounder gun.
300	copper bands for 5-inch rifle shells.
200	copper bands for 7-inch howitzer shells.
60	base plugs for 3.2-inch shells.
800	copper bands for 3.6-inch shells.
50	stocks, cadet fencing musket.
2,570	stocks (wood part).
300	tips.
204	ramrod stops.
212	band springs.
364	side-screw washers.
500	butt-plates.
228	butt-plate screws.
215	stocks, complete.
10	guard-plates.

105	guard-bows.
826	guard-bow swivels.
356	guard-bow swivel-screws.
485	guard-bow nuts.
70	triggers.
276	trigger-screws.
1,044	guard-screws.
50	rear-sight leaves.
1,670	rear-sight screws, front and rear.
3,011	rear sights, complete, 1884.
50	barrels.
2,839	extractors.
469	hinge-pins.
4,153	ejector springs.
1,754	ejector spring spindles.
330	ejector studs.
44	cam-latches.
120	breech-block caps.
102	thumb-pieces.
430	breech-block cap-screws.
75	breech-blocks, complete.
5,769	firing pins.
1,723	firing-pin screws.
2,318	cam-latch springs.
2,266	front-sights.
369	front-sight covers.
383	front-sight cover screws.
2,355	front-sight pins.
1,060	tang screws.
467	bands, upper.
1,694	bands, lower.
137	lock plates.
525	mainsprings.
744	mainspring swivels.
695	mainspring swivel rivets.
1,072	hammers.
1,320	tumblers.
3,453	tumbler screws.
1,812	bridles.
897	bridle screws.
999	sears.
889	sear screws.
1,241	sear springs.
650	sear-spring screws.
1,272	side screws.
68	ramrods.
5,014	ramrods, jointed.
151	bayonets.
34	bayonet clasps.
40	bayonet-clasp screws.
30	bayonets, complete.
16	locks, complete.
10	stocks, assembled.
25	guards, complete.
307	tumblers, swiveled.
1	part of officer's sword.

26	rod bayonet heads, Springfield rod-bayonet rifle.
5	rear sights, Hotchkiss navy rifle.
110	extractors, Springfield shotgun.
26	stocks (wood part) Hotchkiss navy rifle.
1	stock (wood part) Springfield shotgun.
32	stocks, Colt's revolvers.
1	scabbard, officer's sword.
1,319	front-sights, complete.
500	canteen covers.
50	metal parts, picket rope, section 3.2-inch gun carriages.
60	saber attachments.
126	brass snap-hooks.
1	brass hook.
1	brass oval ring.
2,439	saber straps.
120	slings for saber belts.
153	brass slides for saber belts.
1	set metal parts steel bayonet scabbard.
40	bridle reins.
50	girth straps.
2,000	halter straps.
9	bridles.
9	bridles with lead reins.
65	brass hoods for canteen straps.
50	cincha attachments.
2,024	rings, brass, 1¼-inch.
524	rings, iron, 2½-inch.
100	rings, iron, 3-inch.
2,500	staples for rings.
1	pair wooden stirrups.
3	stirrups with guidon socket.
529	pairs stirrups, hooded.
12,700	cartridge bags, empty, 3-inch gun.
1,000	cartridge bags, empty, 8-inch muzzle-loading rifle.
9,955	cartridge bags, empty, 6-pounder gun.
730	cartridge bags, empty, 12-pounder field howitzer.
1,631	cartridge bags, empty, 3.2-inch rifle.
500	cartridge bags, empty, 30-pounder gun.
64	cartridge bags, empty, 12-inch breech-loading rifled mortar.
250	cartridge bags, empty, 12-pounder mountain howitzer.
19	cartridge bags, empty, 4.5-inch rifle.
78	cartridge bags, empty, 5-inch breech-loading rifle.
30	cartridge bags, empty, 7-inch breech-loading howitzer.
1,864	cartridge bags, empty, 12-pounder gun.
433	cartridge bags, empty, 10-inch Rodman gun.
60	cartridge bags, empty, 15-inch smooth-bore gun.
2,781,300	cartridge primers.
5,500	cartridge shells, rifle.
40,000	cartridge shells, revolvers.
100	fuse cases, paper.
612	parts of targets.
3,405	parts of "Laidley's" revolving targets.
9,000	cloth silhouettes.
162	parts of "Brinton" targets.
170	parts of "Cushing" targets.
164	rails for targets.

15	parts of artillery targets.
65,135	paper silhouettes.
871	parts of bench reloading tools.
237	silver bars for sharpshooters' badges.
2	funnels No. 20 shell, shotgun.
7	parts of primer inserting tool.
1	stand.
1	shell rest and screw.
30	priming tool spindles.
1	stem, revolver, assembling and crimping tool.
1	pair bushings, revolver inserting tool.
1	pin wrench.
1	die wrench.
1	total length gauge.
12	key-pins, assorted.
1	pin screw, primer extractor tool.

TOOLS AND MISCELLANEOUS.

260	arm-chests.
2,630	packing-boxes.
312	tin cans.
2	field-cases.
2	packing crates.
15	boxes packing, "Williston."
6	canvas bags.
1	canvas coal-bag.
10	arm-chests for light artillery.
43	boxes, shoeing.
1	saddle and breeching for harness for horse-rake.
49	anvil-boxes.
612	augers, armorers'.
171	aprons, smiths'.
534	brushes.
113	bits, assorted.
140	quarts blacking for leather.
2	calipers.
62	caliper arms.
637	chisels, various.
15	clamps, saddlers'.
551	chamois-skin cases for swords.
593	dies, various.
1,070	drills.
1	drift.
1	die, bullet.
600	discs, pressure gauge.
5	funnels.
1,104	files, assorted.
505	files, rotary.
48	gauges.
1,300	gas-checks.
3	gauges, cylinder.
1	gauge, crusher, pressure.
2	gauges, pressure.
20	pressure gauge-springs.
100	pressure gauge-washers.

5	gauges, ring, for setting star gauge.
8	thickness, gauges.
1	gauge, ring.
2	gauges, front sight.
1	set gauges for Hotchkiss ammunition.
200	cylinders, crusher pressure-gauge.
12	measuring-rods, adjustable.
1	hand-barrow.
1	hammer.
15	horses, saddlers'.
54	handles.
12	hardies.
6	inspecting instruments, 12-inch breech-loading mortar.
100	boxes ingredients for leather blacking.
2	knives, saddlers'.
3	knives, for cutting gauges.
83	gallons lacker.
61	mallets.
1	machine, sun-printing.
1	spur-strap shape-cutter.
1	machine, cartridge-heading.
1,431	mills, armorers'.
64	mandrels.
11	sets measuring-points, star gauges.
1	micrometer measuring instrument.
1	oil-can.
7,020	pounds harness oil.
55	oilers.
9	punches, assorted.
10	pounds white paint.
181½	pounds black paint.
430	pounds olive paint.
236	pounds lead-color paint.
20	pounds putty.
4	watering-pots.
6	dust-pans.
50	portable arm racks for rifle and revolver.
245	reamers.
3	sets roller points, star gauge.
12	pairs magazine slippers.
3	stamps, seal.
15	sets stencil plates and letters.
1	square.
2	powder sieves.
1	set stencil outfit.
6	steel stamps.
116	taps, various.
3	tool-chests.
287	tools for current service.
51	tool-boxes.
2	targets, small arms velocity, Shultz chronograph.
2	wrenches.
43	anvil blocks.
58	boundary-posts for military reservation.
100	bottles ink for marking outfits.
50	pounds hektograph composition.

1	hektograph.
20	wire scratch-brushes.
5	wire brushes, caliber.
5	wood pulleys.
5	hangers.
10	clamps for hangers.
20	feet 2-inch shafting.
1	section picket rope.
2	bushings, obturator primers.
1	cast-iron water-heater.
4	button brushes.
154	button sticks.
1	pattern for sight cases.
100	cans wheel grease and spatulas.
70	cleaning plates, sheet-iron.
12	water-buckets, galvanized iron.
24	stakes, pointing.
1	hektograph pan.
2	cast-iron tablets for national cemeteries.
30	boxes stencil paste.

APPENDIX 2.

Statement of principal articles procured by purchase during the year ended June 30, 1889.

CLASS III.

56	Buckets, watering.

CLASS VI.

38	Spencer repeating shotguns.
1	breech-loading arm, Lindley's patent.
1	Smith & Wesson hammerless safety revolver, caliber .38.

CLASS VII.

5,000	cavalry saddle blankets.
6,006	cartridge-belts.
160	cartridge-belts and plates, woven.
6	curry-combs.
6	horse-brushes.
5,000	knives.
5,000	forks.
5,000	spoons.

CLASS VIII.

137,020	pounds small-arms powder.
3,984¾	pounds black prismatic powder.
3,622¾	pounds brown prismatic powder.
21,600	pounds hexagonal powder.
25	pounds rifle powder.
1,450	pounds blasting powder.
600,000	rifle-ball cartridges, caliber .50.
1,000	revolver-ball cartridges, caliber .38.
200	metallic cartridge-shells.
1,100	paper-shells.
1,000	cartridge primers.
4,485	pounds shot.
20,000	gun-wads.

Class IX.

2	double blocks.
2	treble blocks.
2	tackle blocks.
3	sets blocks.
4	hydraulic jacks.
1	differential tackle.
1	set reloading tools.
1	telescopic sight, field-gun.
500	Piper's aiming devices.

Class X.

16,255	parts of Colt's revolvers.
132	parts of shotguns.
46,851	gun-stocks.
114	"Archibald" wheels for artillery carriages.
124½	pounds escutcheon-pins.
10,368	bar-buckles.
6,585	iron rings.
2,160	halter-bolts.
4,968	halter-squares.
1,952	spring-snaps.
1,314	staves for stirrups.
2,880	brass grommets.
6	horse-collars.
60	parts of saddles.
55	wrought-iron axles for gun-carriages.
198	parts of artillery harness.
50	parts of Hotchkiss rifle, caliber .45.

PART SECOND.

CLOTH, ROPE, THREAD, ETC.

182¾	yards carpeting.
85⅛	yards cloth, woolen.
5⅜	yards cloth, asbestos.
80	yards cloth, oiled and enameled.
21,333	yards cloth, cotton.
2	yards cloth, rubber.
108¼	yards cloth, silk.
250	yards canvas.
51	yards buckram.
210	yards French satin.
641½	yards felt.
216	yards Canton flannel.
357	yards flannel.
8,077	pounds cotton waste.
1,334	pounds cord and twine.
1,425⅜	yards cord.
273	pounds hair.
210	yards matting.
29	mats.
10	rugs.

125	pounds oakum.
45	pounds marline.
17,154½	pounds rope.
2,187¼	pounds thread.
128	spools thread.
36	towels.
40	yards toweling.
17,645⅜	yards webbing.
150	yards braid.
50⅞	yards gold lace.
137	window-shades.
110	curtains and fixtures.
4	pounds sewing-silk.
80	pounds yarn.
100	pounds jute.
108	yards tape.

FORAGE.

10,613	pounds barley.
12,570	pounds bran.
762¼	bushels corn.
25	barrels flour.
24⅛	bushels grass-seed.
185	pounds grass-seed.
4,100	pounds ground feed.
$20\frac{1882}{2000}$	tons hay.
29,490	pounds meal.
6,763	bushels oats.
26	barrels salt.
3,133	pounds lump salt.
$10\frac{1872}{2000}$	tons straw.

IRONMONGERY.

4,020	pounds anchors.
46½	pounds babbitt-metal.
16	bath-tubs and fixtures.
11,190	pounds I and channel beams.
5	boilers.
5,189	bolts.
6½	pounds bolts.
257¼	pounds brads.
148	pounds brass rods.
318,679	pounds brass, sheet.
360	pounds burrs.
9,825	buckles.
24,480	buttons.
2,481	pounds bronze and brass castings.
165,152	pounds iron castings.
165	pounds steel castings.
2,948	feet chain.
2,555	cocks, assorted.
19,477¼	pounds bar copper.
27,320	pounds cartridge copper.
7,115	pounds sheet-copper.
2	sets couplings.

1,020	couplings.
92	door catches and fixtures.
3	sets door catches and fixtures.
261,730	eyelets.
40	pennyweights gold.
2,329	gas-burners.
284	gas-fixtures.
17	papers glaziers' points.
1,030	pairs hinges.
7,730	hooks, assorted.
28,499	horseshoes.
3,084	pounds horseshoe-nails.
100	pounds toe-calks.
77	hose fittings.
6,353	pounds hoop-iron.
157	tons pig-iron.
5,874½	pounds sheet-iron.
156,770½	pounds wrought-iron.
2,516¼	pounds lightning-rod attachments.
164	knobs, assorted.
300	keys and blanks.
654,414⅓	pounds lead.
597	locks, assorted.
1⅓	pounds mica.
60,392⅛	pounds nails.
7,454	pounds nuts.
108	nuts.
305	pounds copper coiled pipe.
5,121	pounds lead pipe.
95,046½	feet iron pipe.
80	feet brass pipe.
18	pounds brass pipe.
754¾	pounds pipe fittings.
22,608	pipe-fittings, assorted.
177	pulleys.
15	pumps.
66	radiators.
10	reducers.
1,987¾	pounds rivets, assorted.
2,331½	pounds rivets and burrs.
1,718	pounds metallic rope.
2,431¼	gross screws.
279	gross screw-pins and eyes.
4	sinks.
640	pounds sash-weights.
834	pounds solder.
330⅞	pounds German silver.
22,050½	pennyweights sterling silver.
7,059	pounds spikes.
6	springs, assorted.
36	staples.
285,791¼	pounds bar and plate steel.
3,942	pounds steel forgings.
3,580½	pounds sheet-steel.
4,676,903	tacks, assorted.
325	pounds tacks, assorted.

54,401	pounds block-tin.
673	pounds tinfoil.
56	boxes sheet-tin.
1,050	tin-can screws.
26½	pounds tubing.
33⅓	feet tubing.
38¾	pounds washers.
451	pounds bronze wire.
3,325⅞	pounds brass wire.
264	pounds annealed iron wire.
7,584½	pounds copper cartridge-wire.
235	pounds copper wire.
435⅝	pounds copper-covered wire.
7,041⅜	pounds iron wire.
318¼	pounds insulated copper wire.
449¾	pounds machine stitching wire.
16	pounds German silver wire.
5,914⅜	pounds steel wire.
6,746	pounds zinc.
5,182⅜	square feet wire-cloth.
495	square yards wire-cloth.
250	feet wire netting and grating.
61	water-closets and fixtures.
10	urinals.
38	window fixtures.
8	sets window fixtures.
5	pounds window fixtures.
5,121	pounds iron T rails.

LEATHER.

424½	pounds black wax.
226	sheep-skins.
25	dog-fish skins.
1	raw-hide.
196	feet rubber belting.
11,508	feet leather belting.
1,480½	pounds bristles.
1,200	feet belt lacing.
56,953	pounds harness leather.
1	side harness leather.
28½	pounds bridle leather.
2,159	sides bridle leather.
76,521½	square feet collar leather.
143	pounds bull-neck leather.
20,496	square feet bag leather.
20	square feet sole leather.
91	pounds sole leather.
205½	pounds walrus leather.
352½	square feet lace leather.
118	sides lace leather.
39	pounds trunk leather.
256	pounds buff leather.
310	pounds belt leather.
181	square feet enameled leather.
10	yards enameled leather.

LUMBER.

792, 574	feet boards.
2, 400	feet battens.
20, 835	feet joists.
2, 000	bundles laths.
15, 500	laths.
796, 453	feet plank.
100	posts and rails.
81, 754	feet scantling.
86, 500	shingles.
182, 700	feet timber.
80	piles.

BUILDING MATERIAL.

682, 990	bricks.
2, 794	barrels cement.
5	cement pipes.
125	feet cement pipe.
6	barrels clay
14$\frac{2}{3}$	bushels clay
4, 334	feet drain-pipe.
26	drain-pipes.
3, 980	feet roofing felt.
2, 443	square feet flagging.
3, 466$\frac{10}{12}$	feet window glass.
4, 161	lights window glass.
160	cubic yards gravel.
30	bushels plastering hair.
977	barrels lime.
711$\frac{1}{4}$	bushels lime.
39	barrels plaster of Paris.
1, 400	pounds plaster of Paris.
1, 329$\frac{1}{2}$	cubic yards sand.
1, 026$\frac{1}{2}$	bushels sand.
973$\frac{62}{100}$	cubic yards stone.
26$\frac{1}{2}$	tons crushed stone.
55	cubic yards crushed stone.
6, 181	slates.
8, 100	feet tarred paper.
150	pounds tarred paper.
126	rolls wall paper.
6	rolls bordering paper.
40	yards bordering paper.
3, 014	feet moldings.
172	feet terra cotta pipe.
1	terra cotta trap.
63	tiles.
540$\frac{7}{8}$	feet tiles.
16	pairs window sash.
13	window sash.
652	feet weather strips.

HEATING, LIGHTING, ETC.

400	pounds anti-incrustation fluid for boilers.
1	barrel blacking for leather.
17	quarts blacking for leather.

562	brooms.
87	brushes, dusting, etc.
56	bath-bricks.
128	pounds candles.
5	chandeliers.
151	square feet card-clothing.
13,110	bushels charcoal.
156	barrels charcoal.
258	chamois-skins.
2,755$\frac{1768}{2240}$	tons anthracite coal.
3,708$\frac{2173}{2240}$	tons bitumiuous coal.
178,192	pounds coke.
416	bushels coke.
290	pounds coruudum.
729	corundum and emery wheels.
68½	reams crocus and emery cloth.
25	carats diamond powder.
2,547	pounds emery.
20,471	fire-bricks.
14	sets fire-bricks.
59½	cords fire-wood.
33	grates and fixtures.
5,600	pounds fluor-spar.
3	tons kaoliu.
97	lanterns.
5	lamps.
638	lamp fixtures.
13	pounds lamp-wick.
676	lamp-wicks.
35	gross matches.
52	mops and handles.
16	pounds Putz pomade.
40	pounds pumice stone.
80	pounds paraffine.
2	furnaces.
789	pounds rotten-stone.
2	pounds rosin.
1	barrel rosin.
75$\frac{6}{20}$	reams sand-paper.
74	cakes sapolio.
5,938¾	pounds soap.
831	gallons soft soap.
2	barrels core-sand.
58	tous molding sand.
341¼	pounds sponge.
24	stoves.
53	stove-fixtures.
30	pounds stove polish.
12	papers stove polish.
30	stove-pipe elbows.
268	feet stove-pipe.
112	pounds stove-pipe.
156	feet steam-pipe covering.
58	barrels sea-coal facings.
3,621	pounds sea-coal facings.
560	pounds tripoli.

705	pounds quartz.
21	wash-stands and fixtures.
2	sets wash-stand fixtures.
10	wash tubs.
3	barrels distillers returns.
26½	pounds vulcanized fiber.

MATERIALS FOR OFFICE USE.

120	blocks, memorandum.
388	sheets, blotters.
2	baskets, letter.
16	baskets, waste paper.
65	books, reference.
1	record case.
1	chest of drawers.
4	office desks.
2	office tables.
62	chairs and stools.
3	chair cushions.
2	clocks.
24	cards.
650	sheets card-board.
15⅓	pounds card-board.
1	composition roller.
4	cuspidors.
144	drawing instruments.
1	set drawing instruments.
20	bottles drawing material.
3, 595	dials for watch-clock.
19, 750	envelopes.
2	electrotypes.
24	file-boxes.
2	erasers.
25	pieces india-rubber.
16	pieces india-ink.
75	bottles india-ink.
87	bottles ink.
3	pounds printer's ink.
12	leads for pencils.
1	letter-press.
9	bottles mucilage.
71¼	reams paper.
1, 048	sheets paper.
15, 500	labels.
72	pads.
602	pencils.
2	boxes crayons.
8	boxes paper-fasteners.
2, 720	paper-fasteners.
2	paper-folders.
140⅓	gross pens.
10	pounds pins.
38	pencil and pen holders.
132	pencil-point protectors.
1	type-writer.

5	ribbons for type-writer.
128	fonts of type.
39¼	pounds type-metal.
8	type-holders.
6	spools tape.
19	gross rubber bands.
45	rubber stamps.
3	quarts hektograph composition.
33	pounds roller composition.
15	boxes seals.
65	sheets stencil board.
119	pounds sealing-wax.
102	yards tracing-cloth.
12	rolls tracing-cloth.
264	thumb tacks.
2,000	tags.

LABORATORY STORES.

110	bottles.
12	thermometers.
5,832	corks.
134	crucibles.
3	glass funnels.
14	gauge glasses.
27	glass tubes.
212	glass jars.
629	electrical supplies.
494	parts of electric batteries.
3	test glasses.
161	photographic materials.
22,387¾	pounds acids.
2	gallons acids.
548⅜	gallons alcohol.
1¼	gallons tincture of arnica.
29	pounds alum.
65	pounds aqua ammonia.
26½	pounds antimony.
248½	pounds beeswax.
101,447	pounds ground bone.
95½	pounds borax.
3	pounds camphor.
533	pounds cream of tartar.
204	pounds chalk.
75	pounds chlorides, various.
30	grains chloride of gold.
850	pounds copper and its preparations.
66	cans concentrated lye.
60	pounds concentrated lye.
300	pounds electropion fluid.
25	pounds flaxseed.
1,165	pounds glue.
5	gallons glue.
257	pounds glycerine.
10	pounds gelatine.
200	pounds ground glass.
14	pounds gum arabic.

36	pounds gum tragacanth.
6	hand grenades.
100	pounds glauber salts.
12	bottles insect powder.
1	pound tincture iodine.
54	pounds iron and its preparations.
2	gallons molasses.
65	pounds mercury and its salts.
15	ounces nitrate of silver.
11,407	pounds sal-soda.
1,512	pounds soda and its preparations.
44,195	pounds straw boards.
130	pounds sal ammoniac.
20	barrels pitch.
885⅛	pounds potash, various.
315⅜	reams paper
41,462¾	pounds paper.
62	rolls paper
1,629	yards paper.
3,317⅛	pounds tallow.
6	pounds tobacco.
529	gallons vinegar.

PAINTS, OILS, ETC.

387	pounds asphaltum.
61½	gallons benzine.
8	boxes bronze, copper.
10	gallons coal tar.
6	barrels coal tar.
99	gallons drier.
32,783	gallons gasoline.
491	pounds kalsomine.
105	pounds litharge.
344	pounds lamp black.
120	pounds lubricating compound.
220	pounds black-lead.
301½	pounds red-lead
24,893½	pounds white-lead.
33	pounds extract of logwood.
8	ounces lacker for brass.
413½	gallons naphtha.
13	pounds nut-galls.
17½	gallons castor-oil.
278	gallons cod-liver oil.
482	gallons dressing oil.
30	pounds dressing oil.
2,013¼	gallons illuminating oil.
7,300½	gallons lubricating oil.
2,994	gallons oil, mixing paints.
5,678	pounds paint, dry.
8,308½	pounds paint, in oil.
50	pounds paint, water colors.
143	gallons paint, in oil.
2,065½	gallons petroleum and its products.
672	pounds putty.

483	pounds shellac.
5	gallons shellac.
1, 603½	gallons spirits of turpentine.
172	gallons varnish.
5, 732	pounds whiting.
681	pounds zinc.
½	gallon oil of tar.

MISCELLANEOUS.

1	row-boat.
12	boat oars.
337	barrels.
24	baskets.
915	burlap sacks.
13, 450	pasteboard boxes.
139	tin cans.
162	boxes axle grease.
782	pounds axle grease.
19	horses.
2, 905	feet rubber hose.
4, 696½	pounds Japan wax.
36	feet packing, various.
598¾	pounds packing, various.
2	rubber aprons.
4	rubber coats.
1	pair rubber gloves.
12	rubber gaskets.
26¼	pounds gaskets.
10	pairs rubber boots.
48	pairs rubber shoes.
108	rubber rings.
214½	pounds rubber rings, etc.
745¾	pounds rubber, sheet.
50	feet rubber tubing.
5¼	pounds rubber tubing.
1, 300	tickets, railroad and street car.
3	trucks.
6	parts of wagons.
1	set wagon-wheels.
19	whips.
3, 620	fertilizers.
46	cords manure.
3	water-coolers.
3	charts.
13	gallons belt dressing.
60	pounds belt dressing.
12	covers for horses.
8	barrels sawdust.
40	cords sawdust.
1	gross Bottom's cement.
46	gallons acme resolvent.
1	clock-spring.
200	shade trees.
6	sets harness.
51	parts of harness.
100	powder-kegs, metallic.

INSPECTING INSTRUMENTS.

1 Vernier caliper.
3 steel rules.
1 telescopic alidade for plane table.
4 microscopes.

MACHINES.

1 "Buckeye" mower.
2 hay-rakes.
1 reaping-machine.
1 wiring-machine.
1 tin folder.
1 swing stock, with cutter-dies.
1 cultivator.
3 crimpers for paper shells.
1 gas-main forcing-pump.
1 paint-mill.
1 tool-grinder.
1 special floor grinder.
1 wire stitching machine.
2 stone rollers.
3 "Singer" sewing-machines.
2 standard cement testers.
1 pipe-vise crane.
1 pipe proving pump and gauge.
1 pipe-cutter and screw-plate.
1 Greenfield vertical engine.
1 hydraulic press and pump.
1 Concord wood-planer.
1 double universal wood-worker
17 parts of engines.
1 beading-machine.
1 lawn-sprinkler.
1 milling-machine.
1 10 inch slotting-machine.
2 force-pumps.
1 graduating-machine.
7 lawn-mowers.
4 engine-lathes.
1 steam-boiler.
1 steam-pump.
185 parts of mowing-machines.
91 parts of machines.
1 10-inch pillar shaper.
2 drag scrapers.
1 jointing-machine.
1 folding-machine.
1 shaping-machine.
2 steel pressure-blowers.

TOOLS, ETC.

29 utensils, various.
138 buckets.
36 coal-hods.

18	dies.
1	set dies.
20	squares.
1	diamond tool.
1	glazier's diamond.
42	steel brushes.
2	pairs pliers.
1	screw plate.
18	plumbers' tools.
606	saddlers' tools, various.
236	smiths' tools, various.
33	taps.
5	sets taps.
9	trowels.
7	tape-lines.
1	gas-furnace (tinners').
39	vises.
125	wrenches.
97	wheel-barrows.
38	sand-stones.
120	pounds sand-stones.
384	spades and shovels.
98	saws.
288	saw-blades.
114	pairs shears.
56	screw-drivers.
43	scythes.
48	scythe stones.
9	scythe snaths.
12	sieves and sifters.
110	stamps.
6	set stamps.
5	platform scales.
1	counter scale.
80	nippers.
702	papers needles.
100	oilers.
118	oil stones.
39½	pounds oil stones.
44	picks.
8	planes.
15	plows and points.
183	punches.
76	rakes.
1,604	rasps.
151	rules.
822	awls.
61	axes.
123	bits.
63	sets of bits.
1,093	brushes, paint, assorted.
26	chisels.
824½	pounds chalk lines.
83	carpenter's tools, various.
408	drills.
2	sets drills.

11,073	files.
36	forks, hay and manure.
25	gauges.
9	gouges.
57,424	pounds grindstones.
240	hammers and hatchets.
1,364	handles, assorted.
54	hoes.
86	knives.
2	ladders.
36	levels.
14	mallets.
132	machinists' tools.
2	sets pipe taps.
2	paint burners.
1	set tools for No. 4 screw machine.

APPENDIX 3.

Statement of ordnance, ordnance stores, etc., issued to the military establishment including the national homes for soldiers of the volunteer and regular army and exclusive of the militia, during the fiscal year ended June 30, 1889.

CLASS I.

1	Gatling gun, 10 short barrels, caliber .45.
5	Gatling guns, 10 long barrels, caliber .45.
4	Hotchkiss mountain guns, caliber 1.65.
9	3-inch rifled guns.
15	3.2-inch rifled guns.
2	8-inch converted rifled guns.
2	6-pounder bronze guns.
3	12-pounder bronze guns.
1	12-pounder field howitzer.

CLASS II.

5	Gatling gun carriages and limbers, metallic.
1	Gatling gun cart.
4	Hotchkiss mountain gun carriages.
10	3-inch gun carriages and limbers.
11	3-inch gun carriages without limbers.
9	3.2-inch gun carriages and limbers, metal.
1	3.2-inch gun carriage (light), metal.
1	5-inch gun carriage, steel.
2	8-inch siege howitzer carriages.
2	6-pounder gun carriages and limbers.
2	12-pounder gun carriages and limbers.
4	12-pounder gun carriages.
1	12-pounder howitzer carriage and limber.
1	Hotchkiss revolving cannon caisson.
4	3-inch gun caissons and limbers.
1	field limber without ammunition chest.
1	cavalry forge cart.
7	cavalry forges.
1	portable forge chest.
1	portable tool chest.

CLASS III.

2	elevating bars.
2	shot carrying bars.
2	baskets for mortar implements

1	wooden forge bucket.
12	iron sponge buckets.
4	wooden sponge buckets.
12	iron tar buckets.
82	gutta percha watering buckets.
23	iron water buckets.
8	leather water buckets.
3	breech covers.
18	fuse blocks.
10	fuse cutters.
1	fuse extractor.
4	fuse gimlets.
1	fuse gouge.
2	fuse mallets.
12	fuse-plug wrenches.
3	fuse saws.
2	fuse setters.
9	gunners' reamers.
20	gunners' gimlets.
31	gunners' haversacks.
9	gunners' pincers.
9	gunners' pouches.
8	pairs gunners' sleeves.
12	handspikes, maneuvering.
18	handspikes, shod.
35	handspikes, trail.
55	harness bags.
1	set harness, Gatling gun, near horse.
1	set harness, Gatling gun, off horse.
50	sets harness, 2 lead horses.
50½	sets harness, 2 wheel horses.
1	set harness, cavalry forge, 2 horses.
4	sets harness, Hotchkiss mountain gun, 2 horses.
3	common lanterns.
2	dark lanterns.
13	globe lanterns.
2	magazine lanterns.
36	lanyards.
5	muzzle covers.
2	pass boxes.
4	paulins, 5 by 5 feet.
12	paulins, 6 by 10 feet.
2	paulins, 8 by 10 feet.
8	paulins, 11 by 11 feet.
75	paulins, 12 by 15 feet.
4	pendulum hausses, 3-inch gun.
2	pendulum hausses, 12-pounder gun.
9	pendulum hausse pouches.
3	pendulum hausse seats.
2	powder measures.
8	primer pouches.
89	priming wires, field.
7	prolonges.
2	quoins.
9	rammers and staves, 3.2-inch gun.
4	rammers and staves, 8-inch rifle.

2	front sights.
2	front sights, 3.2-inch bronze gun.
2	front sights, 3.2-inch steel gun.
8	rear sights, 3.2-inch bronze guns.
2	rear sights, 3.2-inch steel guns.
2	rear sight seats.
1	sponge cover, 6-pounder gun.
17	sponge covers, 12-pounder gun.
3	sponge covers, mountain howitzer.
36	sponge covers, 3-inch gun.
10	sponge covers, 3.2-inch gun, bore.
9	sponge covers, 3.2-inch gun, chamber.
6	sponge covers, 4.5-inch gun.
4	sponge covers, 8-inch rifle.
29	sponges and rammers, 3-inch gun.
10	sponges and rammers, 3.2-inch gun.
2	sponges and rammers, 6-pounder gun.
10	sponges and rammers, 12-pounder gun.
2	sponges and rammers, 12-pounder howitzer.
6	sponges and rammers, mountain howitzer.
9	sponges and staves, 3.2-inch rifle.
18	sponges and staves, 8-inch rifle.
5	sponges and staves, 13-inch mortar.
5	sponges and staves, 15-inch gun.
85	thumbstalls.
4	tompions, 6-pounder gun.
6	tompions, 12-pounder gun.
1	tompion, 12-pounder howitzer.
21	tompions, 3-inch gun.
3	tompions, 3.2-inch gun.
3	tompions, 8-inch gun.
1	tompion, 8-inch mortar.
1	tompion, 10-inch mortar.
12	tompions, 15-inch gun.
13	tube pouches.
21	vent covers.
11	vent pieces.
22	vent punches.
24	wipers for mortars.
4	worms and staves.

IMPLEMENTS FOR GATLING GUN.

3	cam extractors.
3	clamps for worm gear.
5	drifts.
148	feed cases.
8	feed guides.
12	feed magazines.
6	gun covers.
4	headless shell-extractors.
3	oilers.
2	oscillators.
3	pointing-levers.
6	lock screw-drivers.
6	small screw-drivers.

6	T screw-drivers.
3	shell-drivers.
6	wiping-rods.
3	adjusting screw-wrenches.
6	pin-wrenches.
3	rear guide nut-wrenches.

ACCESSORIES FOR HOTCHKISS CANNON.

1	feed-trough.
1	firing-pin.
2	handspikes.
1	prolonge.
1	leather bucket.
1	cushion for limber chest
3	sponge brushes.
1	screw-driver.
1	grease-box.
1	cleaning brush.
1	universal wrench.
1	zinc charger.

ACCESSORIES FOR HOTCHKISS MOUNTAIN-GUN.

24	ammunition boxes.
4	breech sights.
4	splinter bars.
4	extractors.
4	poles.
4	stop-bolts.
4	oil cans.
4	gun covers.
2	screw-drivers.
4	sponges and staves.
3	vent reamers.
4	gun pads.
2	nippers.
4	pole yokes.
3	lanyards.
3	pin wrenches.
3	splinter bar-hooks.
3	gunners' pouches.
4	gun pack-saddles with cargo and belly cinchas.
4	carriage pack-saddles with cargo and belly cinchas.
4	ammunition pack-saddles with cargo and belly cinchas and lashing ropes.
4	harness bags.
4	wiping brushes.

CLASSES IV AND V.

20	3-inch shot.
70	4.5-inch shot.
555	8-inch M. L. shot.
25	30-pounder shot.
25	30-pounder shell.

2,000	1.5-inch Hotchkiss shell.
500	1.65 inch Hotchkiss shell.
440	3-inch shell.
843	3.2-inch shell.
400	4.5-inch shell.
600	5-inch shell.
350	7-inch shell.
101	8-inch shell.
7	8-inch mortar-shell.
25	10-inch mortar-shell.
69	12-inch mortar-shell.
500	1.65-inch case shot.
120	3-inch case shot.
10	3.2 inch case shot.
70	3-inch canister.

CLASS VI.

3,975	Springfield carbines, caliber .45.
1,394	Colt's revolvers, caliber .45.
146	Schofield S. and W. revolvers, caliber .45.
1,589	Springfield rifles, caliber .45.
238	Springfield M. L. rifle-muskets, caliber .58.
40	Springfield shot-guns.
38	Spencer repeating shot-guns.
10	artillery officers' sabers.
6	artillery sabers.
1,195	cavalry sabers.
5	field officers' sabers.
33	foot and staff officers' swords.
56	musicians' swords.
62	non-commissioned officers' swords.
2,657	hunting knives.

CLASS VII.

ARTILLERY ACCOUTERMENTS.

51	knapsacks.
142	saber belts.
142	saber belt-plates.

CAVALRY EQUIPMENTS.

2,065	canteen straps.
3,340	cartridge belts.
2,890	carbine slings.
1,924	carbine-sling swivels.
50	carbine cartridge-pouches.
146	pistol cartridge-pouches.
1,311	pistol holsters.
6	revolver belts.
1,019	saber attachments.
2,125	saber belts.
1,522	saber belt-plates.
1,071	saber knots.
367	saber straps.

INFANTRY EQUIPMENTS.

1,961	bayonet scabbards, steel.
1,675	blanket bags.
1,941	pairs blanket-bag coat-straps.
1,628	pairs blanket-bag shoulder-straps.
8,568	canteens.
624	canteen covers.
45	canteen corks and chains.
5,947	canteen straps.
16	cap pouches.
2,195	cartridge belts.
1,215	cartridge belt-plates.
3,959	cartridge boxes.
96	cartridge boxes, cadet.
5,195	clothing bags.
5,144	clothing-bag straps.
5,913	forks.
250	sliding frogs.
6,656	gun slings.
4,334	haversacks.
3,576	haversack-straps.
3,041	haversacks and straps.
7,888	knives.
7,042	meat-cans.
2,613	hunting-knife scabbards.
7	intrenching-tool scabbards.
5,828	spoons.
7,176	tin cups.
107	waist belts, N. C. O.
105	waist-belt plates, N. C. O.
4,934	waist-belts.
3,108	waist-belt plates.

APPENDAGES.

27	brushes and thongs.
5,055	headless shell extractors.
1,574	jointed ramrods.
13	cleaning rods, shot-gun.
204	screw-drivers, revolver.
2,645	screw-drivers, rifle.
38	screw-drivers, Spencer shot-gun.
103	spring-vises.
366	tumbler-punches.
100	wiping-rods, revolver.
3,550	wiping-rods, rifle and carbine.
38	wiping-rods, Spencer shot-gun.
5	wire caliber brushes.
2	wire scratch brushes.
4	field cases, shot-gun.

HORSE EQUIPMENTS FOR CAVALRY.

1,808	curb bridles.
840	watering-bridles.
1,058	carbine boots and straps.

310	cinchas.
3,893	curry-combs.
228	cruppers.
9	girths.
2,633	halters and straps.
4,198	halter-straps.
3,817	horse-brushes.
821	horse-covers.
2,312	lariats.
989	links.
3,031	nose bags.
1,286	picket-pins.
1	picket-rope, sections.
988	saber-straps for saddle.
772	saddles.
368	saddle-bags, canvas.
1,079	saddle-bags, leather.
4,203	saddle-blankets.
68	saddle-cloths.
1,418	side lines.
3,352	spurs.
5,174	spur-straps.
2,007	stirrups.
4	stirrups with guidon sockets.
2,824	stirrup-straps.
1,581	surcingles.

CLASS VIII.

SMALL-ARM AMMUNITION.

538,516	carbine ball cartridges, caliber .45.
477,581	revolver ball cartridges, caliber .45.
259,000	revolver blank cartridges, caliber .45.
1,415,925	rifle ball cartridges, caliber .45.
423,548	rifle blank cartridges, caliber .45.
108,801	round balls, caliber .45.
1,201,328	carbine-bullets, caliber .45.
379,180	revolver-bullets, caliber .45.
3,268,641	rifle bullets, caliber .45.
65,056	pounds small-arm powder.
6,945,079	cartridge-primers.
7,507	cartridge-shells.
1	shot-gun outfit, except tools and case.
500	paper shells.
12,336	pounds shot.
219,500	cartridge-wads.

AMMUNITION FOR CANNON.

30	blank cartridges, 4.5-inch gun.
200	blank cartridges, 3.2-inch gun.
19,393	blank cartridges, 12-pounder gun.
27,536	blank cartridges, 6-pounder gun.
1,715	blank cartridges, mountain howitzer.
98	combination fuses.

58	metallic fuses.
966	paper fuses.
200	percussion fuses.
257	wooden fuses.
9,900	pounds cannon powder.
26,500	pounds hexagonal powder.
150	pounds mealed powder.
400	pounds mortar powder.
1,550	electric primers.
109,821	friction-primers.

CLASS IX.

28	aiming devices.
83	arm-racks.
1,041	sharp-shooters' badges.
243	bars for sharp-shooters' badges.
18,756	marksman's buttons.
2	elevating bars.
4	fencing-muskets.
50	fencing-musket stocks.
4	fencing-masks.
214	halyards.
3	hydraulic jacks.
1,991	marksman's pins.
11	marking-rods, discs, and brushes.
6	rollers.
14	skids.
10	shifting planks.
150	shot marks and staves.
161	signal-flags.
215	streamers.
2	trunnion rings and keys.

BRINTON TARGETS AND PARTS.

35	targets, complete.
96	cross-pieces.
38	frames.
96	uprights.

CUSHING TARGETS AND PARTS.

22	targets, complete.
10	cross-pieces.
83	frames.
4	truck-wheels.

14	floating targets.
5	spare superstructure for floating target.

16	land targets.
5	spare superstructure for land target.

12	towing targets.
5	spare superstructure for towing target.

LAIDLEY TARGETS AND PARTS.

252	targets, complete.
172	axles.
72	blocks with springs.
18	braces.
456	cross pieces.
4	fish-plates.
8	fish-plate bolts.
453	frames.
150	frame keys.
4	half-boxes.
208	journal-boxes.
333	journal-box pins.
25	journal-posts.
78	levers.
108	lever-blocks.
318	nave boxes.
265	pins, wood.
166	rails.
491	uprights.
458	wedges, wood.

TEXAS TARGETS AND PARTS.

56	targets, complete.
28	centers.
321	frames.
300	keys.
40	posts.
48	washers.

PAPER TARGETS, TARGET MATERIAL, ETC.

40,294	targets.
1	bull's-eye bell.
5,666	centers.
586	frames, steel.
819	frames, wood.
16	frames, double, Wingate.
10,057,500	pasters.
19	plates.
10,022	sillhouettes, cloth.
47,628	sillhouettes, paper.
18,180	strings for skirmish target.

RELOADING TOOLS AND PARTS OF SAME.

40	sets bench-tools.
8	sets hand-tools.
30	sets supplemental tools, Morse.
13	anvils.
20	ball-molds.
25	brush-wipers.
24	chargers, hand.
3	crimpers, paper shell.

3	crimping and reloading dies, revolver.
26	crimping and reloading dies, rifle.
2	resizing dies, revolver.
47	resizing dies, rifle.
20	drifts.
36	extractor-pins.
16	funnels.
90	gauges, resizing.
28	ladles.
15	mallets.
12	oil-cans.
35	priming-tools.
229	priming-tool pins.
15	priming-tool spindles.
2	priming-tool spindle-screws.
4	reloading punches, revolver.
23	reloading punches, carbine and rifle.
26	resizing-punches.
12	shell-scrapers.
60	shell-scrapers, Morse.
1	strainer.
69	wiping-rods.

PARTS BENCH RELOADING TOOLS.

Resizing-tools and parts.

2	resizing-tools.
3	rings.
1	cartridge-head adjusting-screw.
115	dies, lower
24	dies, upper, revolver.
551	dies, upper, rifle.
1	screw-disc.
13	spindles
1	stand.
2	lever-pins.
2	lever-pin screws.
2	link-pins.
6	link-pin screws.

Assembling and crimping tools and parts.

2	assembling and crimping tools.
15	dies.
1	check lever spring.
1	check lever spring screw.
1	shell rest.
1	shell rest set screw.
1	stem, revolver.
5	stems, rifle.
1	stem-carrier.
2	stem lever pins.
2	stem lever pin screws.
2	stem screws.

Powder-charging tools and parts.

1	powder-charging tool.
2	chargers and dies.
1	charger slide and screw.
2	receivers and funnels.
1	receiver nut.
4	wrenches.

Primer-extracting tools and parts.

4	primer-extracting tools.
1	cartridge-holder plate.
98	extractor-pins.
4	spindles.
7	spindle-screws.

Primer-inserting tools and parts.

1	primer-inserting tool.
2	bushings, revolver.
3	bushings, carbine and rifle.
1	bushing screw.
2	pinion levers.
5	primer-setters.
2	ejector pins.
12	key pins.
1	die wrench.
1	pin wrench.
1	total-length gauge.

GALLERY TOOLS.

9	ball-molds.
4	melting-ladles.
4	pouring-ladles.
4	strainers.

CLASS X.

PERTAINING TO CLASS I.

2	screw studs, 3.2-inch rifle.
1	crank spring, Gatling gun.
1	oscillator, Gatling gun.
2	tripods and oscillators, Gatling gun.

PERTAINING TO CLASS II.

Parts artillery carriages.

1	ammunition chest.
3	bolts and nuts.
2	bow-spring brakes.
18	spring brakes.
2	brake rods.

2	chains and hasps for sponge and rammer.
2	car-plate keys and chains for worm and staff.
1	fork with pintle and axle clamp.
12	foot-boards.
4	foot-board bolsters.
16	foot-board bolts.
16	foot-board brackets.
21	linchpins.
6	linch-washers.
32	nails.
1	pintle-hook.
58	poles.
8	pole-straps.
9	pole-yokes.
4	rails.
2	retraction ropes, wire.
8	stay pins with keys and chains.
8	trays.
4	washers.
19	wheels.

Parts Hotchkiss gun carriage.

1	linchpin.
1	trunnion-cap pin.
1	washer with ring.
2	wheels.

Parts cavalry forge-cart.

2	lever rods.
1	shaft.

PERTAINING TO CLASS III.

Parts artillery equipments and implements.

1	bit.
4	breast-straps.
23	bridle ornaments.
392	brass-plated buckles.
658	iron roller buckles.
28	collars.
5	girths.
25	halters.
12	halter-chains.
2	pairs hames.
17	pole-pads.
44	pole-straps.
9	rammer heads.
45	rosettes.
3	valise saddles.
15	sponge heads.
4	sponge and rammer staves.
1	sponge and rammer staff-chain.
316	woolen sponges.

22	brass stirrups.
25	stirrup bars.
1	trace.
5	trace-ropes.
6	trussing-straps.
111	whips.

PERTAINING TO CLASS V.

Parts artillery projectiles.

300	copper bands for 5-inch rifle shell.
200	copper bands for 7-inch howitzer shell.
600	base plugs for 3.2-inch shell.
250	sabots, 10-inch.
400	tin straps.

PERTAINING TO CLASS VI.

Parts Springfield carbin.

6	bands.
28	band springs.
286	bridles.
286	bridle screws.
254	breech-block cap screws.
143	butt-plate screws.
279	cam-latch springs.
659	ejector springs.
709	ejector-spring spindles.
127	extractors.
558	firing-pins.
254	firing-pin screws.
414	front sights.
519	front-sight covers.
404	front-sight pins.
100	guard bows.
2	lock plates.
127	mainsprings.
16	mainspring swivels.
6	pistol-grips.
21	pistol-grip screws.
1,044	rear sights.
160	rear-sight base screws.
12	sears.
266	sear screws.
139	sear springs.
12	sear-spring screws.
124	side screws.
730	stocks.
24	swivel bars.
24	swivel-bar rings.
24	tang screws.
98	tumblers.
352	tumbler screws.

Parts Springfield rifle.

1,059	lower bands.
420	upper bands.
240	band springs.
24	bayonets.
6	bayonet clasps.
374	bayonet-clasp screws.
523	breech-block cap screws.
887	bridles.
962	bridle screws.
10	butt plates.
174	butt-plate screws.
913	cam-latch springs.
2,019	ejector springs.
1,937	ejector-spring spindles.
475	ejector studs.
4,137	extractors.
3,313	firing-pins.
556	firing-pin screws.
20	firing-pin springs.
1,152	front-sights.
269	front-sight covers.
445	front-sight cover screws.
1,104	front-sight pins.
27	guard bows.
126	guard-bow nuts.
532	guard-bow swivels.
52	guard-bow swivel screws.
25	guard plates.
891	guard screws.
278	hammers.
584	hinge-pins.
3	locks.
115	lock plates.
599	mainsprings.
5	mainspring screws.
158	mainspring swivels.
644	mainspring swivel rivets.
27	pistol-grips.
196	pistol-grip screws.
57	ramrods.
23	ramrod stops.
1,945	rear sights.
196	rear-sight base screws.
534	rear-sight screws, front and rear.
26	rod-bayonet heads.
679	sears.
1,106	sear screws.
1,382	sear springs.
438	sear-spring screws.
1,074	side screws.
346	side-screw washers.
1,201	stocks.
361	tang screws.
343	tips.

46	tip screws.
116	triggers.
39	trigger screws.
911	tumblers.
1,779	tumbler screws.

Parts Hotchkiss rifle.

88	extractors.
83	mainsprings.

Parts Lee rifle.

13	extractors.
18	extractor springs.
18	firing-pins.
840	magazines.
81	magazine springs.
18	mainsprings.
18	searsprings.

Parts Parker shot-gun.

6	mainsprings.
6	plungers.
6	plunger springs.
6	tumbler screws.

Parts Spencer shot-gun.

5	cartridge stop springs.
5	cartridge stop screws.
5	firing-pins.
1	firing-pin spring.
4	magazine springs.
5	mainsprings.
5	sear springs.
10	side plate screws.

Parts Springfield shot-gun.

118	extractors.
1	stock.

Parts Colt's revolver.

229	back straps.
702	back-strap screws.
239	bolts.
739	bolt screws.
304	center-pins.
257	center-pin bushings.
483	center-pin catch-screws.
2	center-pin screws.
63	cylinders.
293	ejector heads.
519	ejector rods.
290	ejector springs.

250	ejector tubes.
624	ejector-tube screws.
163	firing pins.
149	firing-pin rivets.
4	frames.
30	gates.
414	gate-catches.
73	gate catch screws.
60	gate springs.
100	guards.
1,044	guard screws.
752	hammers.
269	hammer-cams.
122	hammer-rolls.
22	hammer-roll rivets.
420	hammer screws.
813	hands.
629	hand springs.
505	mainsprings.
305	mainspring screws.
5	recoil plates.
15	sear springs.
15	sear-spring screws.
615	sear and stop-bolt springs.
173	sear and stop-bolt spring screws.
153	stop-bolts.
115	stop-bolt screws.
362	stocks.
794	triggers.
114	trigger screws.

Parts Schofield, Smith & Wesson revolvers.

6	barrel catch springs.
6	cylinder catch screws.
30	extractors.
12	extractor springs.
2	hammers.
5	hammer studs.
6	hand springs.
6	mainsprings.
6	pawls.
6	pawl springs.
12	stops.
12	stop pins and springs.
6	strain screws.
6	swivel pins.
10	triggers.
12	trigger pins.
6	trigger springs.

Parts sabers and swords.

24	mouth pieces, cavalry saber.
20	scabbards, cavalry saber.
45	scabbards, musicians' sword, steel.

PERTAINING TO CLASS VII.

417	curb bits.
430	bridle ornaments.
7, 667	brass bar buckles.
4, 968	brass wire buckles.
1, 584	iron bar buckles.
3, 005	iron roller buckles.
115	cincha straps.
2, 460	coat straps.
484	curb straps.
5, 460	brass escutcheon pins.
25	girth straps.
506	halter headstalls.
995	halter bolts.
1, 496	halter rings.
758	halter squares.
528	halter swivel rings.
380	japanned nails.
1, 516	ovals.
1, 976	brass rings.
846	iron D rings.
589	iron rings.
136	brass shields.
300	double-spring lariat snaps.
164	canteen strap snaps.
513	link snaps.
604	steel snaps.
1, 395	saber belt snaps.
637	saber belt slides and hooks.
10	side line chains.
448	side line fasteners.
1	socket for guidon stirrup.
1, 287	brass foot staples.
3, 574	brass staples for rings.
29	stirrup hoods.

PERTAINING TO CLASS VIII.

5, 200	cartridge bags, 3-inch gun.
100	cartridge bags, 3.2-inch gun.
1, 725	cartridge bags, 6-pounder gun.
1, 900	cartridge bags, 12-pounder gun.
730	cartridge bags, 12-pounder howitzer.
250	cartridge bags, mountain howitzer.
450	cartridge bags, 4.5-inch gun.
1, 150	cartridge bags, 8-inch gun.
1, 016	cartridge bags, 10-inch gun.
50	cartridge bags, 15-inch gun.
400	fuse plugs, wood.
3, 000	gas checks, Morse cartridge.

PART SECOND.

CLOTH, ROPE, THREAD, ETC.

15, 529¼	yards cotton cloth.
114	pounds cotton waste.
4	pieces sash cord.
65¾	pounds sash cord.
21	pounds braided sash cord.
10	pounds marline.
299	pounds rope.
851¾	pounds thread.
116½	pounds twine.

IRONMONGERY.

10	target anchors.
10	pounds brads.
15, 390	horseshoes.
453	pounds iron.
1	pound copper nails.
1, 525	pounds horseshoe nails.
850	pounds iron cut-nails.
266	padlocks.
298½	pounds brass rivets and burrs.
816	pounds copper rivets and burrs.
119	pounds iron rivets and burrs.
51½	gross brass screw pins.
140	gross brass screws.
34	gross iron screws.
10¼	pounds solder.
378	pounds steel.
17, 220	copper tacks.
44½	pounds copper tacks.
1, 851, 100	iron tacks.
$87\frac{11}{16}$	pounds iron tacks.
10	pounds brass wire.
5½	pounds steel wire.

LEATHER, ETC.

133½	quarts leathor blacking.
68	boxes ingredients for leather blacking.
200	pounds blackwax.
$9\frac{25}{32}$	ounces bristles.
956	sides bridle leather.
23, 259	pounds harness leather.
131¾	pounds leather polish.
3	sheepskins.

LUMBER.

2, 952	feet boards.
1, 500	feet plank.
1, 609	feet scantling.
416⅔	feet timber.

CLEANING, HEATING, AND LIGHTING.

51	bath bricks.
108	corn brooms.
14	dusting brushes.
5	feather dusting brushes.
201	button brushes.
198	button sticks.
7	wire scratch-brushes.
60	pounds candles.
143	chamois skins.
8	boxes cleaning material.
80	cleaning plates.
12,400	pounds coal.
33	quires crocus cloth.
1,206½	quires emery cloth.
131	quires emery paper.
3	pounds lamp-wicking.
444	ounces scouring material.
6	pounds pomade.
50	pounds plaster Paris.
561½	pounds rottenstone.
45½	quires sand-paper.
3,023	pounds castile soap.
140	pounds common soap.
181	pounds sponge.
649	papers tripoli.
242¼	pounds whiting.

MATERIAL FOR OFFICE USE.

6	half-boxes blacking for stencil outfit.
142	instruction books.
2	letter-press brushes.
17	stencil brushes.
1	hektograph.
25	pounds hektograph composition.
28	ounces indelible ink.
2	ink pads for marking outfit.
1	door mat.
14	marking outfits.
2	boxes stencil paste.
92	pounds petroleum paper.
50	pounds sealing wax.
21	sets stencil outfits.
7	stencil plates, sets.
1	set thumb-screws for marking outfit.

LABORATORY STORES.

72	pounds sulphuric acid.
1	gallon muriatic acid.
31	gallons alcohol.
84½	pounds beeswax,
2	pounds borax.
250	pounds sulphate copper.

26	pounds chalk.
1	barrel flour.
30	pounds glue.
30	pounds bichromate potassa.
30	pounds chlorate potassa.
400	pounds packing paper.
20	pounds tallow.
1,773½	pounds Japan wax.
5	gallons whisky.

OILS, PAINTS, ETC.

185	gallons coal-tar.
31	quarts cosmolubric.
41¾	gallons Japan drier.
83	pounds lacker.
10½	gallons lacker.
33	pounds lamp-black.
100	pounds red lead.
555	pounds white lead.
12	pounds extract logwood.
3	gallons castor oil.
90¾	gallons cosmoline oil.
6,389	pounds harness oil.
48	gallons kerosene oil.
5	gallons lard oil.
642⅜	gallons linseed oil.
107½	gallons neat's-foot oil.
476	gallons neutral oil.
609¼	gallons sperm oil.
20	gallons whale oil.
20	pounds yellow ochre.
979	pounds black paint.
2,465	pounds brown paint.
25	pounds green paint.
691	pounds lead-color paint.
3,084½	pounds olive paint.
37	pounds vermillion paint.
10	pounds white paint.
50	pounds putty.
543⅒	gallons turpentine.
1	gallon varnish.

MISCELLANEOUS ARTICLES.

2	nail bags.
2	tack bags.
2	tool bags.
23	powder barrels, metal.
75	powder barrels, wood.
1	cleaning material box.
6	reloading tool boxes.
1	tool-box.
48	insulator-brackets.
1	oil-can.
20	tin cans.

1	wheel-grease can and spatula.
16	chamois-skin saber-cases.
33	chamois-skin sword-cases.
2	anvil and block chests.
308	arm-chests.
6	forge-chests.
383½	pounds axle-grease.
397½	pounds wheel-grease.
16	halliards.
108	insulators.

MACHINES AND PARTS OF MACHINES.

600	discs.
1	crusher pressure-gauge.
200	cylinder pressure-gauges.
800	pressure-gauge gas-checks.
1	front-sight gauge, carbine.
1	front-sight gauge, rifle.
8	thickness-gauges.
6	measuring-points.
3	roller-points.
1	firing-rest.
5	ordnance stamps.

TOOLS.

1	anvil.
3	anvils and blocks.
134	aprons.
497	awls.
241	awl-handles.
35	patent awl-handles.
2	axes.
20	ax-handles.
11	bits.
3	lead punching blocks.
5	shoeing-boxes.
1	brace.
321	brushes.
3	buckets.
3	buttresses.
15	calipers.
65	chisels.
12	saddlers' clamps.
19	claw tools.
11	clenching-irons.
57	compasses.
3	countersinks.
2	creasers and fore punches.
31	iron creasers.
14	wooden creasers.
12	crescents.
6	pairs dies.
7	die stocks.
1	drill.
57	edge tools.

476	files.
24	file handles.
3	fullers.
11	draw-gauges.
1	gimlet.
2	grindstones.
124	assorted hammers.
4	sledge hammers.
5	hammer handles.
1	hand barrow.
4	hatchets.
37	hardies.
19	saddlers' horses.
1	jackscrew.
221	assorted knives.
1	drawing knife.
25	splitting knives.
2	levels.
28	mallets.
6	maul handles.
12	armorers' mills.
2	nail claws.
6,536	needles.
23	nippers.
4	oil cans.
2	oil droppers.
11	oil stones.
1	sewing palm.
3	pickaxes.
4	pickaxe handles.
48	pincers.
3	planes.
2	pokers.
7	pricking carriages.
21	pricking wheels.
19	pritchels.
123	assorted punches.
8	nail punches and clinch knives.
70	spring punches.
4	rakes.
998	rasps.
1	reaping hook.
3	riveting irons.
22	rivet sets.
58	rules.
35	sandstones.
8	saws.
2	saw sets.
1	counter scales.
1	platform scales.
28	screw-drivers.
3	scythes.
2	scythe-snaths.
5	scythe-stones.
19	shears.
5	shovels.

2	sickles.
5	slickers.
23	pairs magazine slippers.
4	spades.
7	squares.
4	taps.
8	tap-screws.
13	thimbles.
5	ticklers.
49	tongs.
6	bench-vises.
14	hand-vises.
1	wheelbarrow.
20	wrenches.

APPENDIX 4.

Statement of ordnance, ordnance stores, etc., distributed to the militia from July 1, 1888, *to June* 30, 1889, *under sections* 1661 *and* 1667, *Revised Statutes United States.*

CLASS I.

4	3-inch wrought-iron guns.
8	Gatling guns, 10 barrels, long, caliber .45.
2	6-pounder bronze guns.

CLASS II.

4	carriages and limbers for 3-inch guns.
8	carriages and limbers for Gatling guns, caliber .45.
2	carriages and limbers for 6-pounder bronze guns.
4	caissons and limbers for 6-pounder bronze guns.
8	caissons and limbers for 3-inch guns.

CLASS III.

6	fuse blocks.
12	fuse cutters.
8	fuse gouges.
6	fuse wrenches.
19	gunners' haversacks.
18	gunners' gimlets.
16	gunners' pincers.
24	handspikes, trail.
34	lanyards.
46	priming wires.
18	prolonges.
10	poles, spare.
34	pole-pads.
16	pole-straps.
25	paulins, 12 by 15 feet.
13	pendulum hausses.
13	pendulum hausse pouches.
4	pendulum hausse seats.
5	padlocks, brass, with keys, for limber chest.
22	sets artillery harness, 2 horses, lead.
37	sets artillery harness, 2 horses, wheel.
8	coupling straps, bridle.
8	sponge buckets, iron.
13	sponges and rammers, 12-pounder gun.
10	sponges and rammers, 10-pounder gun.

4	sponges and rammers, 6-pounder gun.
33	sponges and rammers, 3 inch rifle.
6	sponge covers, 12-pounder gun.
4	sponge covers, 6-pounder gun.
18	sponge covers, 3-inch rifle.
6	sponges, woolen, 12-pounder gun.
10	sponges, woolen, 6-pounder gun.
18	sponges, woolen, 3-inch rifle.
56	thumbstalls.
18	tar buckets, iron.
26	tube pouches.
21	tow hooks.
13	tompions.
20	vent covers.
20	vent punches.
13	worms and staves.
44	whips, artillery.
24	water buckets.
6	bridles, artillery, near horse.
6	saddles, artillery, drivers.

IMPLEMENTS FOR GATLING GUNS.

16	feed magazines.
8	gun covers.
12	handspikes.
6	hammers, riveting.
6	oilers.
6	sight-cases.
6	screw-wrenches.
6	wiping-rods.

Classes IV and V.

20	10-inch shot.
30	10-inch shell.
40	12-pounder canister, filled and fixed.
200	3 inch Absterdam shell, time fuse.
100	3-inch Hotchkiss percussion shell.
50	3-inch Hotchkiss time-shell.
30	3-inch Hotchkiss canister, fixed.
150	3-inch Hotchkiss canister.

Class VI.

7,466	Springfield rifles, caliber .45.
60	Springfield cadet rifles, caliber .45.
2	Springfield rifles, officers' model, caliber .45.
641	Springfield carbines, caliber .45.
312	Colts' revolvers, caliber .45.
53	officers' swords.
149	non-commissioned officers' swords.
3	musicians' swords.
182	sabres, light artillery.
525	sabres, light cavalry.
232	sabres, cavalry officers.
132	bayonets.

CLASS VII.

6,819	combination screw-drivers.
6,797	headless shell extractors.

HORSE EQUIPMENTS FOR CAVALRY.

655	curb-bridles, cavalry.
315	pairs spurs.
325	pairs spur-straps.
737	cavalry saddles, leather.
166	artillery saddle-blankets.
300	cavalry saddle-blankets.
100	saddle-cloths, officers'.
12	saddle-cloths for general staff officers.
219	halters and straps.
5	back-straps, front.
5	back-straps, rear.
220	horse brushes.
140	nose bags.
220	currycombs.
6	hair girths.
5	curb bits.
10	curb straps.
60	saddle coat straps.
60	bridle reins.
80	canteen straps, cavalry.
6	stirrups, hooded.
6	stirrup straps.
10	cincha straps.
4	stirrups, with hood and socket.
4	housings for brigadier-general's saddle.
1	housing for major-general's saddle.
12	brow bands and ornaments.

INFANTRY EQUIPMENTS.

9,487	bayonet scabbards.
2,847	blanket-bags.
2,847	pairs blanket-bag shoulder straps.
2,947	pairs coat-straps.
8,198	canteens and straps.
351	cartridge belts and plates.
8,929	cartridge boxes.
1,151	cartridge belts, woven.
9,808	gun slings.
2,973	haversacks and straps.
8,135	waist belts and plates.
1,400	waist belts.
425	waist belt plates.
76	waist belts and plates, non-commissioned officers'.
39	shoulder belts and plates, non-commissioned officers'.
142	frogs, sliding.
11	sword belts and plates, non-commissioned officers'.
1,100	meat cans.
750	tin cups.

2,250	knives.
1,250	forks.
1,250	spoons.
500	canteen corks and chains.
150	cartridge boxes, No. 2, caliber .50.
500	cartridge belt plates.
75	cartridge belts with buckle.

ARTILLERY ACCOUTERMENTS.

548	artillery saber belts and plates.

CAVALRY EQUIPMENTS.

451	carbine slings.
340	carbine-sling swivels.
309	pistol holsters.
150	pistol cartridge-pouches (cap-pouches).
465	saber belts and plates.
100	saber knots.
100	saber attachments.
181	sword belts and plates, officers'.
100	snap-hooks.

CLASS VIII.

550	blank cartridges, 12-pounder gun.
850	blank cartridges, 6-pounder gun.
2,300	blank cartridges, 3-inch rifle.
753,000	rifle ball cartridges, caliber .45.
661,000	rifle ball cartridges, caliber .50.
5,000	rifle ball cartridges, caliber .45, "Morse."
233,000	rifle blank cartridges, caliber .45.
37,000	rifle blank cartridges, caliber .50.
34,000	carbine ball cartridges, caliber .45.
1,000	carbine blank cartridges, caliber .45.
18,900	revolver ball cartidges, caliber .45.
7,000	revolver blank cartridges, caliber .45.
50,000	round balls (140 grains), caliber .45.
60,000	cartridge primers.
27,200	friction primers.
500	fuses, time, paper.
20	fuse plugs, time.
600	fuses, Bormann.
500	cartridge-bags, 3-inch gun.
500	pounds cannon powder.
1,100	pounds mortar powder.
50	pounds small-arms powder.

MISCELLANEOUS.

385	arm-chests.
14	boxes cleaning materials.
169	chamois-skin cases.
481	jointed ramrods.
520	marksmans' buttons.
702,000	pasters.

3,575	paper targets.
150	centers for paper targets.
115	sharp-shooters' badges.
6,847	wiping-rods, wooden.
20	wire scratch-brushes.
2	dies (2 pieces) 405-grain bullet.
7	sets hand reloading tools.
2	sets bench reloading tools.

PARTS OF SPRINGFIELD RIFLE, CALIBER .45.

90	bridles.
160	bridle-screws.
50	breech-blocks.
70	breech-block cap screws.
28	butt plate screws.
20	bayonet clasps.
20	bayonet-clasp screws.
200	cam-latches.
300	cam-latch springs.
505	ejector springs.
430	ejector-spring spindles.
320	extractors.
10	ejector studs.
320	front sights.
300	front-sight covers.
300	front-sight cover screws.
220	front-sight pins.
100	front-sight rivets.
3,080	firing-pins.
250	firing-pin screws.
100	guard-bow nuts.
270	guard-bow swivels.
250	guard-bow swivel screws.
20	guard-bow swivel rivets.
100	guard screws.
320	hammers.
25	hinge-pins.
100	lower bands.
25	lock plates.
180	mainsprings.
170	mainspring swivels.
180	mainspring swivel rivets.
470	rear sights.
150	rear-sight joint pins.
101	rear-sight slides.
50	rear-sight bases.
200	rear-sight base screws.
100	rear-sight base springs.
100	rear-sight slide springs.
150	rear-sight slide spring rivets.
60	ramrods.
150	rear-sight leaves.
550	sears.
100	sear screws.
120	sear springs.

120	sear-spring screws.
400	side screws.
50	side-screw washers.
343	spring vises.
165	stocks, complete.
108	stocks (wood part).
692	tumblers.
800	Tumbler screws.
1,354	tumbler-punches.
190	tang screws.
100	thumb pieces.
120	upper bands, complete.
50	triggers.
58	trigger screws.

PARTS OF SPRINGFIELD RIFLE, CALIBER .50.

200	bayonet clasps.
200	bayonet-clasp screws.
400	cam-latch springs.
300	firing-pins.
200	firing-pin screws.
150	hinge pins.
200	guard screws.
250	guard-bow nuts.
80	hammers.
100	ramrods.
200	rear sights.
100	rear-sight joint screws.
50	rear-sight leaf screws.
100	sear screws.
100	sear-spring screws.
200	stocks (wood part).
100	tumblers.
75	tumbler screws.
200	trigger screws.
250	upper band screws.
200	tips.
100	tang screws.
100	bridle screws.
150	lock plates.

TOOLS, ETC.

4	axes, felling.
4	shovels, long-handled.
4	pick-axes, handled.

APPENDIX 5.

Statement of ordnance, ordnance stores, etc., distributed to colleges from July 1, 1888, *to June* 30, 1889, *under section* 1225, *Revised Statutes of the United States, as amended by act approved July* 5, 1876.

CLASS I.

1 Gatling gun, 10 barrels, long, caliber .45.
13 3-inch wrought-iron guns.

CLASS II.

15 carriages and limbers for 3-inch guns.
1 carriage and limber (metallic) for Gatling gun, caliber .45

CLASS III.

13 gunners' haversacks.
13 handspikes, trail.
26 lanyards.
15 priming wires.
13 paulins, 12 by 15 feet.
26 sponges and rammers, 3-inch rifle.
26 sponge-covers, 3-inch rifle.
26 thumbstalls.
13 tube pouches.
13 vent covers.
13 tompions, 3-inch.
6 pendulum hausses.
6 pendulum hausse seats.
6 pendulum hausse pouches.
1 set artillery harness, 2 horses, wheel.

IMPLEMENTS FOR GATLING GUN.

2 feed guides.
1 hopper for feed guides.
4 feed magazines.

CLASS IV.

1 3-inch Hotchkiss shell, time fuse.
1 3-inch Hotchkiss shell, percussion fuse.
1 3-inch Hotchkiss case shot.
1 3-inch Hotchkiss canister.
1 3-inch Hotchkiss percussion shell, sectional.
1 3-inch Hotchkiss case shot, sectional.

CLASS VI.

1,233	Springfield cadet rifles, caliber .45.
21	non-commissioned officers' swords.
30	light cavalry sabers.

CLASS VII.

1,238	bayonet scabbards.
1,238	cartridge boxes.
1,178	waist belts and plates.
30	saber belts and plates.
15	sword belts and plates, non-commissioned officers'.
8	frogs, sliding.
1,233	headless-shell extractors.
1,233	screw-drivers.
1,233	wooden wiping rods.

CLASS VIII.

250	blank cartridges, 12-pounder gun.
400	blank cartridges, 10-pounder gun.
600	blank cartridges, 6-pounder gun.
1,550	blank cartridges, 3-inch rifle.
47,000	carbine ball cartridges.
39,000	carbine blank cartridges.
7,000	rifle ball cartridges.
2,000	carbine bullets, caliber .45.
2,000	round balls, caliber .45.
4,000	cartridge primers.
8,700	friction primers.
1	3-inch time fuse.
1	3-inch percussion fuse.
1	3-inch time fuse, sectional.
1	3-inch percussion fuse, sectional.
25	pounds small-arms powder.

CLASS IX.

278	paper targets, elliptical, A.
167	paper targets, elliptical, B.
20,200	pasters, white.
19,000	pasters, black.
500	centers for paper targets, A.
500	centers for paper targets, B.
1	set bench reloading tools.
1	target, sliding, Brinton, vertical, 6 by 6 inches.

CLASS X.

100	front sight covers for Springfield rifle, caliber .45.
248	tumbler punches for Springfield rifle, caliber .45.
66	spring vises for Springfield rifle, caliber .45.

TOOLS, ETC.

66	arm-chests.

APPENDIX 6.

Statement of ordnance stores issued to the Executive Departments during the year ended June 30, 1889, *under the provisions of the act of March* 3, 1879.

TO THE TREASURY DEPARTMENT.

12	Springfield carbines.
12	cartridge boxes.
12	waist belts and plates.
500	carbine ball cartridges, reloading.
200	revolver ball cartridges, reloading.

APPENDIX 7.

Report of action taken under the act of March 3, 1881, during the fiscal year ended June 30, 1889.

SOLD TO J. W. FRAZIER.

600,000	percussion caps, regulation, from broken-up ammunition, at 30 cents per thousand	$180.25

SOLD TO WINCHESTER REPEATING ARMS COMPANY.

2,241,200	percussion caps, regulation, at 30 cents per thousand	678.06

APPENDIX 8.

SHOWING STATIONS AND DUTIES OF THE OFFICERS OF THE ORDNANCE DEPARTMENT ON OCTOBER 1, 1889.

Rank and name.	Duty.	Address.
BRIGADIER-GENERAL.		
Stephen V. Benét	Chief of Ordnance	Washington, D. C.
COLONELS.		
1. T. G. Baylor, brevet.	Commanding the Rock Island Arsenal	Rock Island, Ill.
2. J. M. Whittemore	Commanding the Watervliet Arsenal	West Troy, N. Y.
3. A. R. Buffington	Commanding the National Armory	Springfield, Mass.
LIEUTENANT-COLONELS.		
1. D. W. Flagler, brevet	Commanding the Frankford Arsenal, and President of Board for Testing Rifled Cannon, etc.	Philadelphia, Pa.
2. A. Mordecai, brevet	Commanding the New York Arsenal, President of the Ordnance Board, member of Board for Testing Rifled Cannon, etc., and member of the Board of Ordnance and Fortification.	Governor's Island, New York City. P. O. Box, 1449.
3. F. H. Parker, brevet	Commanding the Watertown Arsenal, and member of Board for Testing Rifled Cannon, etc.	Watertown, Mass.
4. J. P. Farley	Member of the Ordnance Board, and member of Board for Testing Rifled Cannon, etc.	Governor's Island, New York City. P. O. box 1449.
MAJORS.		
1. L. S. Babbitt	Commanding the San Antonio Arsenal, and Chief Ordnance Officer Department of Texas.	San Antonio, Tex.
2. W. A. Marye	Commanding the Benicia Arsenal	Benicia, Cal.
3. I. Arnold, jr	Commanding the Fort Monroe Arsenal	Fort Monroe, Va.
4. C. Comly	Commanding the Columbia Arsenal	Columbia, Tenn.
5. J. R. McGinness, brevet	Assistant, Rock Island Arsenal	Rock Island, Ill.
6. G. W. McKee, brevet	Commanding the Allegheny Arsenal	Pittsburgh, Pa.
7. F. H. Phipps	Commanding the U. S. Powder Depot	Dover, N. J.
8. J. W. Reilly	Commanding the Augusta Arsenal	Augusta, Ga.
9. J. A. Kress, brevet	Assistant, Benicia Arsenal	Benicia, Cal.
10. O. E. Michaelis, brevet	Commanding the Kennebec Arsenal	Augusta, Me.
CAPTAINS.		
1. C. E. Dutton	On duty under the Interior Department.	Geological Survey, Washington, D. C.
2. J. G. Butler	Commanding the St. Louis Powder Depot.	Jefferson Barracks, Mo.
3. C. Bryant	Assistant, Frankford Arsenal	Philadelphia, Pa.
4. A. L. Varney	Assistant, Watertown Arsenal	Watertown, Mass.
5. J. C. Clifford	Assistant, National Armory	Springfield, Mass.
6. J. E. Greer	Member of the Ordnance Board, and member of Board for Testing Rifled Cannon, etc.	Governor's Island, New York City. P. O. box 1449.
7. J. Pitman	Commanding the Fort A. Lincoln Ordnance Depot, and Chief Ordnance Officer Department of Dakota	Fort A. Lincoln, Dak.
8. C. Shaler	Assistant, Watervliet Arsenal	West Troy, N. Y.
9. H. Metcalfe	Instructor of Ordnance and Gunnery U. S. Military Academy.	West Point, N. Y.
10. C. S. Smith	Principal assistant in the Ordnance Bureau.	Washington, D. C.
11. S. E. Blunt	Assistant, National Armory	Springfield, Mass.

SHOWING STATIONS AND DUTIES OF THE OFFICERS OF THE ORDNANCE DEPARTMENT ON OCTOBER 1, 1889—Continued.

Rank and name.	Duty.	Address.
CAPTAINS—continued.		
2. F. Heath	Assistant, Watervliet Arsenal	West Troy, N. Y.
13. D. M. Taylor	On special duty in the office of the Adjutant-General.	Washington, D. C.
14. D. A. Lyle	Member of Board on Life-saving Apparatus, etc., under the Secretary of the Treasury, and on duty with U. S. Commission to the Paris Exposition.	27 Ave. de le Bourdonnais, Paris, France.
15. J. Rockwell, jr	Assistant, Rock Island Arsenal	Rock Island, Ill.
16. J. C. Ayres	Assistant, Ordnance Board	Governor's Island, New York City. P. O. Box 1449.
17. M. W. Lyon	Commanding the Cheyenne Ordnance Depot, and Chief Ordnance Officer Department of the Platte.	Cheyenne, Wyo. Ter.
18. C. W. Whipple	Commanding the Fort Leavenworth Ordnance Depot, and Chief Ordnance Officer Department of the Missouri.	Fort Leavenworth, Kans.
19. A. H. Russell	On foundry duty	20 Market Square, Room 54, Providence, R. I.
20. R. Birnie, jr	On duty in the office of the Chief of Ordnance.	Washington, D. C.
21. I. MacNutt	Assistant, Watervliet Arsenal	West Troy, N. Y.
22. C. C. Morrison	Assistant to the Ordnance Board, and Recorder of the Board of Ordnance and Fortification.	Governor's Island, New York City. P. O. Box 1449.
23. F. Baker	Assistant, Frankford Arsenal	Philadelphia, Pa.
24. O. B. Mitcham	Assistant Instructor of Ordnance and Gunnery, U. S. Military Academy.	West Point, N. Y.
FIRST LIEUTENANTS.		
1. H. D. Borup	Military attaché	Legation—Paris, France.
2. L. L. Bruff	Assistant, Watervliet Arsenal	West Troy, N. Y.
3. C. H. Clark	Commanding the Vancouver Barracks Ordnance Depot, and Chief Ordnance Officer Department of the Columbia.	Vancouver Barracks, Wash. Ter.
4. William Crozier	On duty in the office of the Chief of Ordnance (in Europe).	Washington, D. C.
5. W. B. Gordon	Assistant, Watervliet Arsenal	West Troy, N. Y.
6. F. E. Hobbs	On foundry duty	South Bethlehem, Pa.
7. D. A. Howard	do	Providence, R. I.
8. S. E. Stuart	do	Station G, Philadelphia, Pa.
9. J. Walker Benét	On duty in the office of the Chief of Ordnance.	Washington, D. C.
10. W. W. Gibson	Assistant to the Ordnance Board, etc	Governor's Island, New York City. P. O. Box 1449.
11. E. B. Babbitt	Assistant, National Armory	Springfield, Mass.
12. O. M. Lissak	Assistant, Watervliet Arsenal	West Troy, N. Y.
ORDNANCE STORE-KEEPERS.		
Captains.		
A. S. M. Morgan	On duty, Allegheny Arsenal	Pittsburgh, Pa.
W. H. Rexford	On duty, Indianapolis Arsenal	Indianapolis, Ind.
M. J. Grealish	On duty, Augusta Arsenal	Augusta, Ga.
V. McNally	On duty in the office of the Chief of Ordnance.	Washington, D. C.

APPENDIX 9.

REPORT OF THE PURCHASING OFFICERS OF THE ORDNANCE DEPARTMENT, SHOWING THAT SMALL PURCHASES CAN NOT BE MADE AS ADVANTAGEOUSLY BY ADVERTISING AS IF PERMITTED TO BE MADE IN OPEN MARKET, IN THE MANNER COMMON AMONG BUSINESS MEN.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., October 12, 1888.

SIR: The Chief of Ordnance has recommended that section 3709 of the Revised Statutes shall not apply to purchases of supplies of less value than $200, and he requests that you will make report based on your experience in making small purchases by the present method of advertising for proposals.

It has been stated that these small purchases can not be made as economically by the present method as by resort to open market purchase, and moreover that the responsible business houses which furnish acceptable materials in many cases refuse to make bids under advertisements for small orders, being unwilling to incur the trouble and the formality the present system requires, and that when induced by personal requests to send in proposals they are generally above the prices at which they offer to sell like supplies over their counters for cash.

He requests that you will give your experience in the matter and generally submit any evidence you possess or arguments you may have to offer as to why the open market purchase of small quantities of supplies would be more advantageous to the United States than by purchasing them under advertisement as now practiced.

Where it is practicable to give facts and figures, please do so.

He requests that you will please forward your reports on this subject with the least practicable delay.

It is proposed to submit these reports to Congress in asking the exemption of small purchases from the operation of existing laws.

Respectfully, your obedient servant,

WILLIAM CROZIER,
Lieutenant Ordnance Department, U. S. Army.

The COMMANDING OFFICER.

Report on present methods of procuring supplies for the Ordnance Department (in reply to circular of Chief of Ordnance, dated October 12, 1888).

FRANKFORD ARSENAL,
Philadelphia, Pa., November 5, 1888.

Under existing regulations supplies and materials for the Ordnance Department are purchased by two methods.

First. Upon formal written contracts made upon proposals received in reply to newspaper advertisement of thirty days. These contracts cover a fiscal year, or the unexpired portion of the same remaining at the time the appropriation acts are passed. These contracts are made to cover all the articles required for specific known work, and all articles that experience suggests may possibly be required for emergencies and possible work, and are for such quantities of each article as the Government may require, more or less, to be delivered at such time as they may be required during the year.

Second. By informal special contracts, under proposals invited by circular-letter advertisement of from ten to thirty days, for immediate delivery of articles the necessity for which was not foreseen when the annual contracts at the beginning of the year were made; usually for emergencies and unexpected work.

NOTE.—A third method called emergency purchases in open market is contemplated but not practiced. The objections to this method made by accounting officers in Washington, the difficulties thrown around it, and the delay of writing to the Chief of Ordnance to obtain permission, and then of issuing circular advertisements for proposals, are such that the second method is rarely less objectionable, no matter what the emergency.

First method.—Much has been accomplished in the way of simplifying and reducing the labor, difficulties, and evils of carrying out this method by receiving the bids on uniform, carefully prepared printed catalogues, containing instructions and explanations to bidders. Notwithstanding this, the labor involved in the method is still enormous. The variety of articles required in connection with manufactures, tools, machinery, building work, and repairs is great. There were 2,582 separate items on the catalogue at this arsenal this year; 96 proposals were received, and 75 contracts made (5 copies of each). Placing the average number of bids on each item at six (estimated), it made 16,492 bids to be considered.

The labor connected with this work, up to the completion of the contracts, required the services of, say, six clerks and foremen nearly three months.

EVILS OF THE FIRST METHOD.

(1) Specifications for quality and other matters must be determined a long time before the articles are wanted. The work is great and must be deputed to subordinates. It can not receive the close scrutiny of an officer that is desirable. It is not like waiting till an article is required; having an officer see the necessity for it, see exactly what is wanted, and purchase accordingly. The specifications must be exact, uniform, and bidders must conform thereto exactly in order that bids may be even for comparison. The result is that articles not suitable are purchased and loss results. The magnitude of this evil can not be fully described, except at great length, but will be appreciated by business men without explanation. (This evil does not apply to the regular supplies for known work. It does apply to most of the miscellaneous articles for possible or probable work, and it covers probably 80 per cent. of the articles on the catalogue.)

(2) The papers, business, and clerical labor in connection with the system are so great, and so crowded into one period of the year, so as to be beyond the grasp and comprehension of the officer. It must be run by subordinates, on a system, and can not receive the scrutiny desirable. The result is a tendency to get the papers in such form that they will pass the scrutiny of accounting officers, and to lose sight of purchasing to the advantage of the Government and the work, which should be the prime object. This evil is not slight.

(3) This system is practically what is known as "gambling in futures" on many articles. The market prices will fluctuate during the year. The dealer knows this, and unless he is so venturesome as to be unsafe, in order to insure himself, he must make a price higher than the probable average price, and the Government loses. If the price goes up he sometimes accepts the loss quietly, but more often accepts it as Government oppression. Supplies are obtained with vexatious delays and, if he can effect it, below standard of quality, and the Government reaps part or all the loss. If the price goes down the dealer reaps all the profit.

(4) Many tools, machines, and many other articles are patented, or for other reasons can be furnished by one person only. This is known; bids are useless, and, to the public, foolishness. This brings contempt on the method and on the officer who employs it. This can be borne, but its tendency is to deter the best dealers from bidding, and to lead others to feel that the officer is not a shrewd business man, and to try to take advantage of him in dealings.

(5) Notwithstanding the efforts to simplify the business of the system to bidders through the catalogues mentioned, and in other ways, it is still complex. The contracts (5 copies) and their forms, bonds, and requirements are formidable to them.

Often important firms have their fixed system of doing business, which can not be made to conform. The amount of business is small and the formalities great. These objections, but especially the evils described under 3, and some of those under 1 and 4, deter the best dealers from bidding, and deprive the Government of an important advantage and privilege. At Rock Island I felt this, and could cite cases. Here I have not much acquaintance, except with those who do bid and enter into contract, and can not cite cases, but know the objection described exists. It not only causes loss, but involves a worse evil. Its tendency is to relegate the furnishing of Government supplies to "dealers in Government supplies." Some of these are fair dealers and some are not. It is not too harsh to say that some of them constitute a "ring," and speculate on these supplies. They are acquainted with all Government methods, give low bids, and make it uncomfortable for the officer if he rejects them. They force upon him as poor and cheap an article as possible, know his necessities, that his work will not admit of the delay of rejection and going into open market to purchase (often to have articles manufactured); endeavor to come in contact with foremen and inspectors, and to further their own interests at the expense of the Government.

General remark.—The principal evils are those described, or resulting from what has been stated under 1, 2, 4, and 5. These would in my judgment be almost entirely removed by the plan proposed by the Chief of Ordnance in his circular letter of October 12—that of permitting the purchase in open market of articles costing less than $200 when the interests of the Government demanded it.

EVILS OF THE SECOND METHOD.

(6) Under the second method some of the above difficulties are removed, and others come in. Generally the article is required immediately. Under the system it requires from fifteen to forty days to go through all the required forms and procure it. In the mean time work is delayed and loss incurred.

(7) This method is often an expensive one. I append hereto a sample lot of papers required for such a purchase. The estimated cost of stationery, postage, and clerical labor, and other expenses for getting ready to make such a purchase is as follows:

For issuing circular advertisement to ten bidders:

Clerical labor	$3.25
Superintendent	.50
Stationery—25 circulars, 25 envelopes (large), 2 abstracts, 4 letters	.25
Postage	.60
Total	4.60

The total money amount of the last forty-one purchases made under this system was $1,478, making the expense of carrying out the system, say, 13 per cent. of the cost of the articles purchased. In more than half the cases the cost of the article was less than the cost of preparing these papers, and in many cases less than one-fourth the cost of preparing the papers.

(8) When circulars are issued, specifications as to quality, quantity, weight, dimensions, etc., are fixed by the knowledge at hand, and they must be fixed that bids may be comparable. The bids when received are often fruitful sources of better knowledge. They show that some other unknown, perhaps new and cheaper, article would be better; that a slight departure from specifications would give a better article, would admit many desirable bidders that are excluded, etc. But the regulations will not permit this without the delay of getting new authority to issue new bids, and the work can not wait.

I think of two cases which illustrate the principle of this last evil, though not its magnitude. I had lately to purchase a small lot of asbestus for covering pipes. The "Chalmers Spence" was the best known variety, and was specified. A bidder brought a new article, which for the peculiar special case would have been quite as good, at one-fourth the cost. It could not be accepted. I have at Rock Island called for bids for first clear pine for interior finishing, which is the proper and usually the cheapest lumber for such work. The bids developed the fact that the lumber was not in market and could be obtained only by transporting it from Chicago, and the bids were at high prices accordingly. At these high prices it would have been much better to purchase second clear and incur the labor and waste of cutting out bad parts; but the work could not wait another thirty days.

As stated, these cases illustrate the principle of the evil only.

GENERAL REMARKS ON BOTH METHODS OF MAKING PURCHASES.

However great the care exercised in preparing the catalogue and specifications for bidders, numerous cases arise where important articles required during the year are not on the contracts. It is important for economy and success that they be purchased. The difficulties, and especially the delays, incident to a purchase by the second method are such that it must be avoided if possible. Shift is then made to get along by one of the following methods:

(*a*) To use in lieu of the proper article something that is on the contracts, often a more costly article than the one desired, and not suitable.

(*b*) To improvise or manufacture expensively something that can be made to answer.

(*c*) To get along without any article at all.

All these methods involve loss, and sometimes serious loss.

Under No. 4, above, the difficulties or objections to the purchase by advertisement of patented articles, or articles on which there can be no competition, was alluded to briefly. In addition to these there are a large class of other articles which can not be purchased reasonably or sensibly, under the competition of bids. Among them are such articles as gas fixtures, mantels, grates, some articles of house hardware, many tools, shop fixtures, some machines, many chemicals, furniture, etc. The only practicable method is to go into market as any other buyer would, select what is cheapest and best for the purpose, get the lowest prices possible, and then, for a compliance with regulations, call for formal written bids on the one article selected, with the certain knowledge that no bid can fill requirements and be accepted except the one from the dealer who has the selected article. This is certainly irregular and highly unsatisfactory, but it is the only practicable method. It is unfair to dealers.

During the year improvements and new articles come into use, and especially come to the knowledge of the officer, that were not known when the annual bids were prepared. They are cheaper and better than those on the contracts. The officer can not avail himself of them, to save cost and give better work, because of the delays and difficulties of purchasing under the second method, and because the contractor claims the right to furnish his contracted article. This tends to cast odium on Government work, and on the officer in charge of it. They both receive the epithet of "old fogy."

Among necessary articles which can not be purchased at all under the present system I will specify one, which I wish to purchase at the present time. I am satisfied from experience that several of the foreign steels now used in expensive machine tools at this arsenal, and in reloading-tools issued to the Army, do not give as good results as might be obtained from some cheaper American steels. Some small experiments have proved that this is true. Before introducing this steel, it is necessary first to obtain samples and make experiments; conference with the manufacturer is necessary. He must be shown the tool, and the work it is to perform. He then furnishes a steel he deems best adapted to that one purpose. It is tried, results reported, and new trials made on another quality, and so on until a steel exactly adapted to the work is obtained. This must be done for many varieties of tools. All tool-steel users are familiar with this. It is of the highest importance for economical and successful work. To carry it out numerous samples must be purchased; they can not be purchased under bids and contracts. The method employed then is to explain the matter to the steel manufacturer, induce him to furnish the samples with the understanding that if the steel succeeds a contract will be made with him next year, and he can then be paid for the samples. This is irregular and unsatisfactory. If it fails, I am personally responsible for the steel, must pay for it out of my own pocket, and then try another manufacturer. After the best steel for a particular work is found, grades established, and workmen have learned how to treat it, competitive bids are foolishness. Only that one steel can be used until another series of experiments have established a better.

Another case in point at the present time is the purchase of horses. I am compelled to purchase a draft-horse. Bids for the same were asked for, and the qualities of the horse were specified with great care. Two bids were received, one at $300, one at $249.50, and the latter accepted and a contract made. The contract simply destroyed all competition, and that its only effect. The object sought now is to get as good a horse from one dealer—the contractor—as I can for the money. The only hold I have on him is that if he will not furnish a satisfactory horse I will buy none at all, and he loses the profit on a valuable bargain. If he concludes I must have the horse, this is no hold at all. With the contract I have no competition; without it I would have the competition of all dealers. I believe I could go among farmers and buy a better horse for $200 than I can get from the speculator for $249.50.

In answer to the specific question asked in the circular letter of the Chief of Ordnance, as the result of a long and tedious investigation, I have to state as follows:

First. Do dealers decline to bid because of the difficulties and formalities attending such bids and furnishing such supplies?—Answer. Yes. In consequence of these difficulties under both methods of purchase, but especially under the second method, and also in consequence of the other objectionable features of the methods which I have described in this report, many of the best dealers, from whom it would be desirable to make small purchases, do not respond when called upon to make bids, and the Department can not, therefore, under the system now employed, make purchases from them. Out of 2,239 circular bids sent out requesting dealers to enter prices thereon and return them, only 373 were returned. (This takes into account items when there were several items in one bid.)

Second. Do the difficulties described cause dealers to enter higher prices on circular bids than they would charge for cash sales, and thus enhance prices of Government purchases?—Answer. No; they do not, except in rare cases. A full investigation shows as follows: A majority of dealers on receiving the circulars do not care—for reasons stated—to answer. If they do answer, they enter their regular prices, not much expecting their acceptance, and are indifferent. In an open market purchase, their desire to obtain and retain Government business would have caused them in

NATIONAL ARMORY,
Springfield, Mass., November 6, 1888.

SIR: In accordance with the instructions of the circular letter of October 12 ultimo, relative to small purchases of less than $200 by the present method of advertising for proposals, I have the honor to submit the following:

(1) In the matter of actual price paid for articles so purchased there is little to be said. To buy in open market should not involve increased price. All that can be claimed for the present system, viz, competition, can be equally secured in open market purchases, without loss of time, etc., as detailed below, and the purchase of the right material—material up to the market standard—very much facilitated. Only those who make and have such for sale need then be asked to quote prices before purchase. Advertisement best opens a way for proposals from irresponsible dealers and agents whose material can not be accepted. The following items have during the past three months been purchased under the present system of advertising, that is, purchased under advertisement of ten days for a single and immediate delivery. These few will serve to illustrate this part of the subject, prices paid and prices at which they could have been bought in open market being stated opposite each:

Name of bidder and article.	Cost accepted bid.	Cost in open market.
Kirkham & Estabrook, Springfield, Mass., one 22-inch tin folder	$35.00	$35.00
C. B. Arsino, Springfield, Mass., fifty zincs for batteries	3.50	3.50
J. F. Cranston, Springfield, Mass., two coal-oil lanterns	1.92	1.92
L. H. Mayott, Springfield, Mass., one paper shell crimper No. 12	.65	.65
Homer Foot & Co., Springfield, Mass:		
One hundred pounds hemp rope, ¾-inch	12.50	12.50
One wiring machine	12.00	*12.50
Phillips Manufacturing Company, Springfield, Mass., one No. 4 swing stock, with cutter, dies, etc	21.00	21.00
George A. Graves & Sons, Springfield, Mass., forty dozen Grobert files	73.20	74.70

* This increase the dealers explain would arise if they knew there was no competition. The same would obtain with any special articles—articles not usually kept in stock or in any quantity.

(2) Small purchases—small in amount, but often large in importance in connection with the public interest—are often necessary by reason of unexpected orders. These no amount of forethought can anticipate, and to make them under the law ten days at least must be lost, and in the majority of cases more, as follows: Twenty days are allowed in which to deliver; this time in many cases is not sufficient, and contract must be entered into—not sufficient for various reasons; deliveries are made, which, on account of quality, must be rejected, consuming time to replace them, or bids, contrary to strict injunctions, are made for articles not in possession, which must be procured by purchase elsewhere or by manufacture, and thus in one way or another the twenty days are consumed and still more time when contract must be entered into.

(3) In addition to these unexpected orders requiring purchases, whether from indisposition to bid or failure to observe the call for proposals, there are always a number of items of small amount for a single and immediate delivery in the yearly catalogue of supplies for which no bids are received, and which must be procured afterwards by circular advertisement and request of the armory to dealers to bid, increasing the loss of time, further embarrassing manufacture or issue, and, besides the detriment to the public interests, increasing the cost by additional clerical labor. One case occurring this year will serve to illustrate this. The yearly catalogue of supplies, bids to furnish which were called for by advertisement May 25 in prominent papers of Boston, New York, Philadelphia, and Springfield, contained the item of 40 gallons of neatsfoot oil, value of about $24. The lowest bidder for this item was a firm of Cleveland, Ohio, through an agent in Washington City.

As the requirements for the oil were fully stated in the catalogue, and no just grounds existing for rejecting the bid, it was accepted, it being but one cent less than the bid of a responsible firm that it was known could furnish what was needed. Delivery was made September 1, freight not prepaid as required. The oil being inferior, it was rejected and the firm notified September 3, to which no response was made. October 3 the company was again notified, but without response until the 10th, through a watchman of the armory, whom it had made a local agent. It has taken from August 11, when the order was given for the oil, to the 10th of October to procure, under an advertisement of thirty days, a barrel of neatsfoot oil and to find out that the successful bidder for it could not or would not supply it; this with all its attendant correspondence, etc., when the oil needed could have been bought in a few hours in Springfield, Mass., for a trifle more a gallon. After all this loss of time and expense the armory finds its need still unsupplied and the oil must be re-advertised for to comply with the existing law.

(4) Articles of small value are often to be had only of one man or firm and at one price, and for which there can be no competition. The absurdity is therefore presented of advertising for what only one man or firm can supply, wasting often needful time and putting the supplier to the inconvenience and annoyance of going through with, in such cases, the useless formality of bidding; this, too, often for small amounts. For example, there have been recently made by circular advertisement of ten days' purchases of amounts following from—

The Colt's Patent Fire-Arms Manufacturing Company	$1.72
Winchester Repeating Fire-Arms Company	3.00

(5) As above stated, no increase of cost need attend purchases of small amounts if dealers be invited to quote prices before placing orders. The same proposals can be obtained as now under existing law without loss of time—at least of the ten days before the opening of bids—and with much less clerical labor.

Respectfully, your obedient servant,

A. R. BUFFINGTON,
Lieutenant-Colonel of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

WATERTOWN ARSENAL, *Watertown, Mass., October* 30, 1888.

SIR: In answer to Ordnance Office letter of the 12th instant, I have the honor to submit the following remarks upon the effects of the present method of advertising for proposals when making small purchases at this arsenal:

Section 3709 of the Revised Statutes directs that "All purchases and contracts for supplies or services in any of the departments of the Government, except for personal services, shall be made by advertising a sufficient time previously for proposals respecting the same when the public exigencies do not require the immediate delivery of the articles or performance of the service. When immediate delivery or performance is required by the public exigency the articles or service required may be procured by open-market purchase or contract at the places and in the manner in which such articles are usually bought and sold or such services engaged between individuals."

This section has been interpreted to apply to everything that is purchased by the Ordnance Department except personal services.

If an exception could be made to the provisions of this general law allowing small purchases to be made without advertising for proposals, in cases where the amount of the purchase does not exceed $200, it would be a great relief at this arsenal, and it would, it is thought, be an economical measure to the Government. The principal supplies needed for the year are known, and can generally be provided for by advertisement. But there are many articles, such as special tools, instruments, fixtures, small amounts of material, which can not be foreseen as needed, but which, when occasion requires, at a manufacturing and supplying establishment, are needed without delay in order to continue work to advantage, to which this method of advertising for the lowest bid is particularly inapplicable, as causing vexatious delay and extra expense. The time required under the present system in such cases to procure the article is from twelve to thirty-five days. It would then seem wiser to extend the exceptions to include such cases as these and allow small purchases to be made with celerity and economy.

As regards the comparative economy of the two methods, the proposed method of making small purchases in open market is certainly a saving of the expense of clerks in making out advertisements, blank proposals, abstracts of bids, the printing, and all the formal papers in as great number as if the purchase amounted to a great sum, and this expense in the aggregate amounts to no inconsiderable sum in the course of a year. If the purchase by advertisement is at the lowest market rates, it is evident that the stores have still cost the Government more than they would have if an open-market purchase had been made. But are they really always bought at the lowest market rates? It is believed that they are not, but where the amounts involved are quite small, the better class of dealers do not care to go through the formality of bidding, the amount of profit not paying them for the time and trouble required. The following is one instance:

In November, 1886, I advertised for 1,000 copper strips for projective bands. Only one bid was received in answer, at 35 cents per pound, which I was obliged to reject, as I had received an offer from the Revere Copper Company to sell the strips in open market for 20 cents per pound. December 17 I advertised again, and particularly solicited a bid from the Revere Copper Company, who sent in one at 30 cents—50 per cent. higher than I could buy in open market of the same parties. This had to be accepted or go without. The amount of this purchase was only $137.70. In this case the successful bidder positively refused for a long time to have anything to do with bidding, but finally, when induced to bid, they made the Government pay well for the inconvenience occasioned them.

In March, 1887, a small quantity of steel plate for the fabrication of a 5-inch siege carriage was required. No bid received. Advertised again April 15; only one bid received for one item. May 3 advertised again, and upon repeated solicitations one firm bid to help us out of our difficulty, and after long delay we were enabled to go on with the work of constructing the carriage. The amount of this purchase slightly exceeded $200.

In 1886 Messrs. Austin & Fellows refused to make a contract for one item, which alone had been awarded them as the lowest bidder, although they would have been glad to sell over their counter the articles, which amounted to less than $200.

The above are only a few typical cases where a rigorous application of the advertising system to small purchases occasioned delay, embarrassment, and extra cost.

Of the 298 items advertised for at this arsenal during the fiscal year ending June 30, 1888, about 260 would have cost less than $200.

Of the 282 items for the year ending June 30, 1889, about 250 will be under $200. If these 510 items could have been purchased in open market there is no doubt that money would have been saved to the Government.

I therefore advise and recommend that, if possible, the law be so changed as to exempt from its provisions small purchases amounting to $200 and less, permitting them to be made in open market; but that in all cases where open-market purchases are made that the purchasing officer be required to certify that he has made careful inquiry of all dealers in the vicinity, and that the purchase is made at the lowest market rate.

Very respectfully, your obedient servant,

F. H. PARKER,
Lieutenant-Colonel, Ordnance Department, U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

ALLEGHENY ARSENAL,
Pittsburgh, Pa., October 26, 1888.

SIR: In reply to your circular letter of the 12th instant, relative to making purchases of less value than $200 in open market instead of by advertising for proposals, as is now done, I have the honor to state that I am of the opinion that these small purchases can be made in open market with a much greater advantage to the Government than by advertising for proposals and yearly contracts.

There are responsible business houses in this city who will not bid under advertisements for small orders, claiming that they do not wish to incur the trouble and the formality of the present system. They also state that if they did bid that their prices would be considerably higher, on account of the contracts running for a year, than they would be if the purchases were made over their counters for cash. There is one firm in this city who are large manufacturers of brass cocks, lead pipe, iron gas-pipe, etc., who will not bid for the above reasons, and from whom we could, under open-market purchase, obtain supplies at a reduction of from 10 to 15 per cent. less than our contract prices for the same articles, and this firm sells to plumbers and others who are our contractors at the same prices at which they would sell to us under open-market purchase, and the Government has to pay the increased cost.

Oats are selling here to-day at 33 cents per bushel; we pay 38 cents. Hay is selling at $16.50 to $17 per ton; we pay $20. Corn, shelled, at 52 cents per bushel; we pay 60 cents. Bran is $16 per ton; we pay $18. Oat-straw at $8 per ton; we pay $12. And so on in the same ratio through the whole list of supplies that we have under contract, and I have no doubt that under open-market purchase the cost of the supplies would be reduced from 10 to 15 per cent.

Respectfully, your obedient servant,

GEO. W. MCKEE,
Major of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

AUGUSTA ARSENAL,
Augusta, Ga., November 3, 1888.

SIR: Referring to the proposition to amend section 3709, Revised Statutes, so as to permit open-market purchases of a less value than $200, I have the honor to state that it meets my heartiest approval.

We attempt to make prompt provision for future supplies by embracing in an annual catalogue every article of probable use, but there is such an infinitude of articles falling under the general denomination of "ordnance and ordnance stores," as well as of articles of general and occasional use in the shops and in the repair of machinery, buildings, inclosures, etc, that it is an absolute impossibility for any human being to foresee and provide for their purchase in time to have them available when needed. Or, in case a catalogue were made so comprehensive as to embrace every item of probable use, and these articles were bid upon and contracted for in good faith by responsible parties, and not ordered during the year because not needed, the contractors assume that the officers of the Government are trifling with them and they will not bid a second year. Business men do not care to go through the formalities required for nothing. In fact, unless personally solicited, they will seldom bid on any item or items. And this personal solicitation, as it can not be general, is directly contrary to the spirit of the law. An officer therefore must either break the law in attempting to enforce it, or he may be charged with failure to provide for his post. He is impaled either way.

Again, our annual contracts call for "greater or lesser" quantities than stipulated for, and contractors are going to see that they are on the safe side. They must provide for possible rises in the market value of stores during the fiscal year, so that ordinarily our prevailing rates are much above the current market rates.

There are many small, but very necessary items, which are only dealt in by special dealers, upon which we can seldom get a bid; as, for instance, charcoal for use in the shops. Our annual consumption of this article will average 25 or 30 bushels. This at 10 cents per bushel is $2.50 or $3; not worth contracting for, yet absolutely essential. I could name many other similar items, but this one illustrates the case. We had no charcoal for two years except that I could beg or pick up.

I have repeatedly bought small items for necessary use and paid for them from my own funds, because we could not otherwise obtain them. Yet I do not presume that Congress gives me my salary to run this arsenal upon.

Some two years since we needed a horse to replace a dead one. Bids were called for, time and place fixed for opening proposals, and the hardest lot of broken down old animals were presented that could be gathered together in Augusta. I had either then and there to make a selection or do without a horse, or call for new bids to go through a similar selection. The limit was fixed at $175, while the best horse presented was only priced at $160. I would not have bought him in open market at any price, but he was the best of the lot.

During this year we may need castings of brass or iron to replace broken parts of machinery, tools, etc., but the patterns can not be known beforehand. They may be unique and complicated. No foundry man will contract for so small an item when the chances are that he may lose money.

I am certain the proposed amendment would prove advantageous to the Government, and relieve officers from very frequent embarassing and even ridiculous situations.

Very respectfully, your obedient servant,

J. W. REILLY,
Major of Ordnance, Commanding.

The CHIEF OF ORDNANCE,
Washington, D. C.

FORT MONROE ARSENAL,
Fort Monroe, Va., October 16, 1888.

SIR: In compliance with instructions contained in your circular letter dated October 12, 1888, I have the honor to report that my experience in the purchase of small lots of stores under the present system of advertising for proposals has shown that it entails loss upon the United States by reason of the higher prices asked when proposals are required, the delay caused by the requirement to wait a certain period after advertising before opening bids, and the frequent necessity for advertising a second time with requests to dealers to make bids, none having been made under the first advertisement. By open purchase, without the formality of proposals, lower quotations can generally be obtained and a promptness in delivery, which is frequently of very considerable importance.

There is an unwillingness on the part of the larger business houses to make proposals in competition for small lots of material; their reason being that the profit is not sufficient to pay for the trouble of making formal proposals; and houses that do make proposals add enough to the real value of the articles bid on to pay for their trouble.

To note instances: I advertised in April for a small lot of oak lumber to make securing stakes that were required for immediate use at Fort Monroe; no bids were received, and a second advertisement was made which elicited but two bids specially requested. The lower was accepted at $70 per thousand feet and the lumber was received in June—more than a month after the first advertisement. The contract for anthracite coal for use during the current fiscal year was awarded to the lowest bidder at $7.50 per ton. It can now be bought in open market at $7 per ton. The lowest bid received for yellow-pine flooring was $40 per thousand. The market price was $32.50. The lowest bid for yellow-pine scantling was $35, and it is selling for $30. The bids for cypress piles was $20 each. They can be purchased for $10.

The bids for lumber and piles were rejected, the prices being regarded as excessive. It will be necessary to advertise again for these articles when needed.

Respectfully, your obedient servant,

ISAAC ARNOLD, Jr.,
Major of Ordnance, Commanding.

The CHIEF OF ORDNANCE,
Washington, D. C.

INDIANAPOLIS ARSENAL,
Indianapolis, Ind., October 17, 1888.

SIR: In compliance with the circular letter of the Department dated October 12, 1888, I have the honor to report that while the nature of my duties for some years past has been such that my experience in the purchase of supplies has been but limited, yet it has been sufficient to show beyond question the disadvantages of making small purchases by the present method. I can not recall an instance when such purchases could not have been made at cheaper rates by buying in open market; and when the time and trouble incident to making bids and executing contracts are considered, it is useless to discuss reasons for the unreasonable prices now necessarily paid for supplies furnished in small quantities.

Very respectfully, your obedient servant,

CLIFTON COMLY,
Major of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

UNITED STATES POWDER DEPOT,
Dover, N. J., October 17, 1888.

SIR: Referring to the efforts of the Department to have section 3709 of the Revised Statutes modified so as to exempt from its operation small purchases of less value than $200, I have the honor to report that my experience here and elsewhere has been that the section alluded to often operates to the disadvantage of the United States. Dealers frequently are unwilling to make formal bids for small orders, and when requested to do so to accommodate the requiring officer add to the cash price something for their trouble. Others again quote prices higher than market ones, indifferent as to the result of their bids, but sure of a good price if they are accepted. Great saving of time, labor, and money would result to the United States if the exemption asked for were granted.

Very respectfully, your obedient servant,

FRANK H. PHIPPS,
Major of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

SAINT LOUIS POWDER DEPOT,
Jefferson Barracks, Mo., October 20, 1888.

SIR: In reply to your inquiry as to the bearing of my "experience in making small purchases by the present methods of advertising for proposals," I have to state that my experience as disbursing officer at both large and small arsenals and depots justifies, as a wise and economical measure, your recommendation that section 3709 of the

Revised Statutes shall not apply to purchase of supplies of less value than $200; also, that all the statements in your letter are borne out by facts within my knowledge.

The law may be wisely and skillfully framed to protect the interests of the Government and individuals in large transactions, but it certainly operates to the disadvantage of the Government in the many small purchases which yet aggregate thousands of dollars in the course of a fiscal year, and is, besides, a constant source of embarrassment and annoyance to both purchaser and dealer.

The application of the law to small purchases is indeed considered by the business man as rather farcical, and usually defeats the desire of the officer to procure the best goods at the lowest prices.

I have known at Watertown Arsenal a few trifles to cost several times their market value through a rigid enforcement of the law. As a rule, such extravagance can now be avoided; nevertheless it is only large purchases which can be advantageously placed for the Government.

Let me also instance formal articles of agreement in quintuplicate, with all the accessories of witnesses, red seals, etc., forming a contract for the delivery of one barrel of salt at $1.25 at this depot. (See formally approved contract between Daniel Paule, jr., and Maj. John A. Kress, December 26, 1886.)

Every-day experience at my present station illustrates the unsatisfactory working of the law and the wisdom of the suggested modification.

Advertisements for proposals for supplies for this depot were placed in only three newspapers this year; but the cost, with printing of catalogues, etc., will amount to over 15 per cent. of last year's purchases. This year the purchases will probably amount to $1,500, involving no less than seventeen separate contracts, each in quintuplicate.

Taking no account of time and labor, the cost of advertising, completing contracts, printing, etc., will add fully 10 per cent. to the cost of the article purchased, which, in spite of every reasonable effort on my part, will not average as well in quality as those I could inspect and purchase and "bargain" for in open market.

A law should not be capable of this absurd application; yet instances of this kind are the rule and not the exception in small purchases. There are instances where a liberal construction of a law will serve the public interests, but this appears to have been impossible with this cast-iron statute.

The entire commercial fabric of the world is based upon a system of credits and mutual confidence, and business firms—though their agents deal in dollars where we deal in cents—have no more perfect system of money and property accountability than that of our disbursing bureaus, and this system may be trusted to amply protect the interests of the Government in purchases of any amount. As to fraud in transactions under $200, if we are to discuss that infinitesimal danger, the mere formality of a contract is quite powerless to prevent it, as collusion between parties would probably be quite as easy upon a contract blank as upon any other form of voucher. If an officer be inclined to stain his honor and risk an honorable life position, there is nothing in the present system to prevent him from doing so, unless it be the cheapness at which he would sell himself; for the general market rates being known at the heads of Departments the margin for peculation is certainly small.

Often no attention is paid to advertisements; indeed this is the rule with large dealers. In response to my last advertisements in the form and manner prescribed by the War Department, and costing $101.56, I received only two inquiries, covering two items out of one hundred. Failures of this kind being the rule, printed catalogues and "slips" are prepared at the War Department to be sent by mail to business houses. Even to these I had few responses until I had made personal appeals, and as a result, $100 or $200 worth of material is divided among several large dealers who have done me the favor to bid.

The larger houses, with which it would be of advantage to deal, as a rule care little for the Government patronage, and if they can not have it by standard commercial methods do not wish it at all.

I have known a firm after submitting prices and having them accepted for several thousand dollars' worth of material, politely decline any further dealings by contract with the Government, while glad at all times to sell goods for cash or credit as to other customers. I refer to General P. V. Hagner and N. & G. Taylor, Philadelphia.

The Nelson Manufacturing Company threw my circulars, etc., into the waste-basket. Their agent "did not want to bother with small dealings extending through an entire year." A member of the firm stepped forward and instructed him to "give Captain Butler what he wants." The charity was accepted, of course, in the interest of the Government.

The Rumsey Manufacturing Company, the Simmons Hardware Company, the Shapleigh and Cantwell Hardware Company, all the harness and saddlery companies, the stove, mantel, and grate houses, in fact, four-fifths of the dealers in the special articles wanted paid no attention to advertisements and circulars, and submitted their bids only upon personal solicitation.

Now these men did not abate one cent from their regular prices; they made no effort to "compete;" they simply gave me the prices of their goods, putting it in the form of bids as a personal favor, and the result is that, to get what is required, contracts have to be made with all of them at certainly not less than market rates; and to these prices must be added the cost of completing contracts, advertising, printing, etc. My personal expenses to and from and about the city may amount, during the two months of placing and accepting the bids, to about $25; but several times that would not compensate me for the trouble and annoyance incurred.

The Excelsior Manufacturing Company, through the politeness of its vice-president, executed a contract for a necessary purchase to the amount of $14.50. (Voucher 8, February, 1888.)

The N. O. Nelson Manufacturing Company sold to the United States, under like formality, $11.85 worth of material for repairs (voucher 11, March, 1888). Their prices were fixed and the contracts were superfluities, increasing clerical labor, complicating vouchers, and operating in no sense as an additional check to any irregularity in the purchase.

It is often impossible to classify articles so that bids can be intelligently made upon them; consequently, if you want bids it is necessary to go among dealers, point out the quality or kind of article required, and ask them to submit bids. But men do not care to bid under these circumstances, especially for only two or three articles, or perhaps a single one, and it is difficult to see how bids can be procured in this way without leading each merchant to believe that his bid has at least a very fair show of acceptance. He does not care much for the sale, but he consents to bid and execute a contract to oblige you; and it is not strange if the idea occurs to him that it is hardly possible that you would be guilty of the impertinence of coming into a stranger's place of business and asking him to offer his goods without reasonable expectation that they will be taken. But by the time you have completed your rounds you know who must receive the order, and that all the others will be filling out and transmitting to you a useless form.

The fair course to pursue in this case seems plain enough—namely, to rush back and undo your work by telling the others that their bids will be useless. For an officer had better sacrifice his vanity by appearing absurd than sacrifice his self-respect by a suspicion of bad faith. In future this officer, when no bids are received for a few necessary articles, will probably ask for a bid only from some one party whose prices average lowest, and recommend that the bid be accepted. Of course, either course makes a formal contract quite an absurdity. In fact it is simply impossible under the present system to make small purchases to proper advantage, and private individuals are better served than the Government, in spite of efforts however conscientious on the part of its purchasing agents. These ought not to be placed in a position which often calls for a choice between sacrificing their self-respect or the Government interests: while at best, no matter what their trouble, they can rarely make small purchases below the market rates, to which must always be added the expenses of the system.

Very respectfully, your obedient servant,

JOHN G. BUTLER,
Captain, Ordnance Department, U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

CHEYENNE ORDNANCE DEPOT,
Cheyenne, Wyo., October 23, 1888.

SIR: I have the honor to report upon the subject of purchases in open market for stores aggregating $200 or less in value, that our purchases are so limited at this depot that I have no figures to give; but from my experience in the past at arsenals I am firmly of the opinion that this is the only true, business-like method to adopt; and should a merchant adopt the policy now in use by the Government he would soon have to give away to his more enterprising neighbor. Not only are the stores of poorer quality (for it is hard to so express a contract as to cover all points of excellency), but the additional cost is at least 10 per cent. more, as reliable merchants prefer not to "fool," as they call it, with a contract, but will sell in open market.

Very respectfully, your obedient servant,

MARCUS W. LYON,
Captain of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

FORT LEAVENWORTH ORDNANCE DEPOT,
Fort Leavenworth, Kans., October 17, 1888.

SIR: In reply to your circular letter of the 12th instant, with reference to purchase of supplies of less value than $200, I have the honor to state that in my experience as commanding officer of this depot the only purchase made exemplifies the necessity of your recommendation. I was authorized to obtain, in the usual way, 4,000 feet of lumber, and the only bid received in reply to my advertisement was for an amount about double what I knew it could be purchased for in open market. This bid was of course declined, and in answer to a new advertisement other dealers were induced finally to bid at the same prices they charged in open market, and the lumber was obtained after a delay of about one month.

As the officer in charge of the Proving Ground at Sandy Hook for several years, I was a constant witness of the embarrassment and disadvantage to the Government arising from the application of section 3709 of the Revised Statutes to small purchases, but such cases as I recall will be quoted probably by others.

I may state, however, that, as a consequence of it, I have been obliged to purchase small articles at my own expense to prevent the destruction of Government property.

Very respectfully, your obedient servant,

C. W. WHIPPLE,
Captain of Ordnance, Commanding.

The CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C.

APPENDIX 10.

TRIAL OF THE RUBIN RIFLE.

(2 plates.)

Proceedings of a board convened by virtue of the following indorsements on a letter from the Hon. T. F. Bayard, Secretary of State, to the Hon. William C. Endicott, Secretary of War, dated Department of State, Washington, October 14, 1887.

[First indorsement.]

ORDNANCE OFFICE,
Washington, November 30, 1887.

Respectfully referred to the commanding officer of National Armory. The Rubin repeating rifle is sent to you by express to-day. The cartridges have not been received and the reason is given in the within correspondence. When received they will be sent you. You will notice the condition under which a trial can be had of this gun—the presence of a representative of the Swiss Legation—and when the cartridges are received action will be taken to carry this out.

S. V. BENÉT,
Brig. Gen., Chief of Ordnance.

[Second indorsement.]

NATIONAL ARMORY,
Springfield, Mass., May 26, 1888.

Respectfully referred to a board to consist of Maj. William A. Marye, Capt. J. C. Clifford, Lieut C. H. Clark, Lieut. J. W. Benét, for test of rifle and cartridges, and report, inviting attention to the condition in the first indorsement hereon. The rifle and cartridges will be tested for velocity, recoil, rapidity, accuracy, and penetration at 500 and 1,000 yards and trajectories made for those ranges.

A. R. BUFFINGTON,
Lieut. Col. of Ordnance, Commanding.

NATIONAL ARMORY,
Springfield, Mass., June 1, 1888.

The Board met pursuant to the foregoing indorsements, at 10 a. m. Present, all the members. The Board then carefully examined the mechanism and workings of the Rubin magazine rifle, and the recorder was directed to inform the commanding officer, National Armory, that the Board is ready to proceed with the test of the Rubin rifle as soon as the attendance of a representative of the Swiss Legation can be procured.

The Board then, at 12 m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., August 21, 1888.

The Board met at the call of the president at 10 a. m. Present, all the members. Mr. K. Kloss, a representative of the Swiss Legation, was also present. The Board then proceeded to test the Rubin repeating rifle (Swiss) and cartridges, as follows:

I.—RAPIDITY WITH ACCURACY.

The number of shots which, fired in two minutes from the gun—both as a magazine gun and as a single shooter—strike a target 6 feet by 2 feet, at a distance of 100 feet. Any cartridges missing fire in this or other tests to be tried with a prick punch or opened to ascertain the cause of failure. The test to be begun with the chamber or magazine filled. In the test as magazine gun the paper pockets of cartridges to be torn open and placed on the table; in the test as a single shooter, the cartridges to be disposed at will upon a table.

The gun was operated by Mr. R. T. Hare.

As single shooter, 32 shots, 32 hits. Gun worked satisfactorily.

As magazine gun, 39 shots, 34 hits. Stopped with one cartridge in the chamber. Four cartridges dropped in putting tin case in magazine. Gun worked satisfactorily.

II.—RAPIDITY AT WILL.

The number of shots which can be fired in one minute, irrespective of aim, under the same circumstances as in Test I.

As single shooter, 22 shots, 1 missfire, which failed to explode on three trials. It was afterwards opened and found to be deficient in fulminate. One cartridge dropped.

As magazine gun, 25 shots. Stopped with magazine full. One cartridge dropped.

III.—ACCURACY AND PENETRATION.

Five targets of 10 shots each were then fired from the Rubin rifle at the 500 yard range, for accuracy. The gun was operated by Mr. F. R. Bull, who fired the 50 rounds from the shoulder, using the prone position. The gun was cleaned after each target of 10 shots. The same point was aimed at in every case, the center of the target. Mr. Bull was ignorant where any of his shots struck, until the firing was completed. He complained of the roughness and inaccuracy of the rear site, and the unfamiliar trigger pull, and stated that it was greatly owing to these hindrances that the targets made were no better. The shots were recorded by means of a camera, by the method explained in Appendix 21, Report of Chief of Ordnance, 1882. The targets made were as follows:

	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
First ten rounds	4.44	8.16	9.78	6.48
Second ten rounds	4.88	16.08	18.00	15.12
Third ten rounds	4.56	17.52	18.84	14.16
Fourth ten rounds	6.36	8.88	12.00	9.84
Fifth ten rounds	6.48	14.10	16.68	12.96
Mean	5.34	12.94	15.06	11.71

Plots of these targets showing the positions of the shots are herewith submitted, marked A.

The target used to test the penetration was composed of twenty-four white pine boards one inch thick, placed one inch apart, to facilitate tracing the course of the bullets. Six satisfactory shots were fired from the Rubin rifle and the same number from the Springfield. The following penetrations were obtained:

Number of shot.	Penetration, Rubin.	Penetration, Springfield.	Remarks.
	Inches.	*Inches.*	
1	16.165	11.675	
2	16.181	11.000	Fell between 11 and 12 boards.
3	17.000	10.000	Fell between 10 and 11 boards.
4	16.185	13.125	
5	16.165	12.250	
6	15.089	12.000	Fell between 12 and 13 boards.
Mean....	16.130	11.675	

The Rubin bullets all remained in the wood of the target, while the Springfield bullets in most cases, after penetrating a certain number of boards, fell to the ground. Neither variety of bullet was noticeably deformed in this test. The Board then, at 5:30 p. m., adjourned to meet to-morrow at 9:30 a. m.

NATIONAL ARMORY,
Springfield, Mass., August 22, 1888.

The board met pursuant to adjournment at 9:30 o'clock, a. m. Present, all the members; Mr. K. Kloss also present. Test III was continued, and the following penetrations were obtained at the 1,000-yard range:

Number of shot.	Penetration, Rubin.	Penetration, Springfield.	Remarks.
	Inches.	*Inches.*	
1........	9.00	7.18	
2........	9.00	7.	Fell between seventh and eighth boards.
3........	8.39	7.	
4........	9.78	8.	
5........	8.00	6.	Fell between sixth and seventh boards.
Mean ..	8.83	7.02	

The weather becoming too rainy to fire for accuracy at 1,000 yards, the Board proceeded to other tests as follows:

IV.—VELOCITY.

The LeBoulange chronograph was used in this test to determine the velocity. The distance between the targets was 100 feet. The instrument seemed to work perfectly, and the following results were obtained

Number of shot.	Velocity at 50 feet from the muzzle.	Number of shot.	Velocity at 50 feet from the muzzle.	Number of shot.	Velocity at 50 feet from the muzzle.
1........	1,778	5........	1,764	9........	1,750
2........	1,767	6........	1,761	10........	1,773
3........	1,759	7........	1,746	11........	1,763
4........	1,766	8........	1,746	Mean...	1,761

V.—RECOIL.

The recoil of the Rubin rifle as compared with that of the Springfield was determined by the recoil dynamometer described in Ordnance Notes 31 and 82. The following results were obtained:

Number of shot.	Rubin, recoil.	Springfield, recoil.	Number of shot.	Rubin, recoil.	Springfield, recoil.
	Foot pounds.	*Foot pounds.*		*Foot pounds.*	*Foot pounds.*
1	6.25	13.50	4	6.50	12.50
2	6.50	12.00	5	6.50	12.50
3	6.50	14.00	Mean	6.45	12.90

The weight of the Rubin rifle is 9 pounds 6 ounces, and that of the Springfield used 8 pounds 14 ounces.

Mr. K. Kloss stated that owing to pressing official business he would be unable to be present at the further tests of the Rubin rifle, and desired that those tests should proceed without him. The Board then, at 5 p. m., adjourned to meet to-morrow at 9.30 a. m.

NATIONAL ARMORY,
Springfield, Mass., August 23, 1888.

The Board met pursuant to adjournment, at 9.30 a. m. Present, all the members. Test III, accuracy, was resumed. It was decided by the Board to fire five targets of ten shots each from the Rubin rifle and five similar targets from the Springfield, at the 1,000-yard range, as follows:

Ten shots to be fired alternately from each gun, the same conditions to obtain as in the previous test for accuracy, at 500 yards. The guns were operated by Mr. F. R. Bull. Springfield rifle No. 426116 was used. The following results were obtained:

	Mean horizontal deviation.		Mean vertical deviation.		Radius circle of shots.		Radius 50 per cent. shots.	
	Rubin.	Springfield.	Rubin.	Springfield.	Rubin.	Springfield.	Rubin.	Springfield.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
First ten rounds	22.80	21.72	10.32	34.08	27.18	46.50	19.44	48.48
Second ten rounds	12.72	26.40	20.40	19.02	25.44	33.65	24.24	28.08
Third ten rounds	13.66	12.48	26.16	35.04	81.44	39.78	22.32	50.42
Fourth ten rounds	24.72	19.44	22.41	19.92	35.82	30.36	30.00	25.68
Fifth ten rounds	8.28	10.48	15.36	8.90	19.08	18.00	15.84	16.08
Mean	16.41	18.10	18.93	23.39	27.79	33.65	22.36	33.74

The plotted targets showing the position of the shots are herewith submitted, marked B and C.

The Board then, at 5.45 p. m., adjourned to meet to-morrow at 9.30 a. m.

NATIONAL ARMORY,
Springfield, Mass., August 24, 1888.

The Board met pursuant to adjournment, at 9.30 a. m. Present, all the members. It was decided to fire five targets of ten shots each from the Springfield rifle at the 500-yard range, under the same conditions as obtained when the Rubin rifle was fired at that range for accuracy. Mr. F. R. Bull operated the gun.

The following targets were made, plats of which showing the position of the shots are herewith submitted, marked D. Springfield rifle No. 426116 was used.

	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
First ten shots	8.64	5.04	11.28	7.92
Second ten shots	7.21	8.04	11.34	9.84
Third ten shots	6.00	12.36	14.50	13.44
Fourth ten shots	7.08	8.76	12.36	12.96
Fifth ten shots	6.72	4.80	9.12	8.16
Mean	7.13	7.80	11.72	10.46
Mean of the 5 targets fired from the Rubin rifle at 500 yards	5.34	12.94	15.06	11.71

The Board then, at 12:30 p. m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., August 27, 1888.

The Board met at the call of the president, at 10 a. m. After discussion it was decided to determine the trajectory of the Rubin rifle for 500 yards practically by the use of paper screens, and compare the results obtained with those arrived at by calculating the trajectory by the usual formulas. The range near Chicopee Falls, on the Granby road, known as the Granby Range, was selected as the most suitable place for carrying out the experiment. The recorder was directed to make the necessary preparations, and at 11 a. m. the Board adjourned till to-morrow at 9 a. m.

NATIONAL ARMORY,
Springfield, Mass., August 27, 1888.

The Board met pursuant to adjournment, at 9 a. m. Present, all the members. The Board then proceeded to the Granby Range. A target was established at 500 yards from the firing point, and paper screens were placed at 100, 200, 300, and 400 yards distance. The differences of level were then determined in the usual manner as follows:

Number of observation.	Back station.	Forward station.	Rise.	Fall.	Total rise.	Total fall.
1	2.980	5.807		2.827		2.827
2	5.149	3.778	1.371			1.456
3	4.098	3.474	.624			.832
4	6.255	5.060	1.195		.363	
5	4.638	1.853	2.785		3.148	

Height of gun above leveling peg at firing point, 6 inches.

Horizontal plane through muzzle of gun taken as plane of reference for ordinates of trajectory.

The gun was fired from a fixed rest, which was sunk in a pit so as to bring the muzzle of the gun 6 inches above the leveling peg at the firing point. Several trial shots were fired in order to determine the proper height to be given the screens so as to catch the shots. The Board then, at 6 p. m., adjourned to meet to-morrow at 9 a. m.

NATIONAL ARMORY,
Springfield, Mass., August 29, 1888.

The Board met pursuant to adjournment, at 9 a. m. Present all the members. The Board then proceeded to the Granby Range and resumed the experiments. The firing from the fixed rest was done by R. T. Hare. Satisfactory results were obtained both with the Rubin and Springfield rifles, the shots passing through all of the screens. The following measurements were made:

Distance.	Rubin rifle.			Springfield rifle.		
	Measured ordinates above ground.	Ordinates above peg at gun.	Ordinates above horizontal plane through muzzle.	Measured ordinates above ground.	Ordinates above peg at gun.	Ordinates above horizontal plane through muzzle.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
100 yards	6.859	4.032	3.532	9.216	6.389	5.889
200 yards	7.802	6.346	5.846	11.408	9.952	9.452
300 yards	8.145	7.313	6.813	11.816	10.984	10.484
400 yards	6.286	6.648	6.148	8.800	9.163	8.663
Target	.781	3.929	3.329	.850	3.998	3.498

This gives for the approximate height of the ordinates above the line of sight:

	Rubin.	Springfield.
	Feet.	*Feet.*
100 yards	2.866	5.190
200 yards	4.514	8.053
300 yards	4.816	8.385
400 yards	3.484	5.864

These ordinates were then computed by the recorder from the formula

$$\frac{y}{x} = \tan\varphi - \frac{G}{2\cos^2\varphi}\left\{\frac{A(u')-A(V)}{S(u')-S(V)} - I(V)\right\}$$

page 84, Exterior Ballistics, by Capt. J. M. Ingalls, Fort Monroe, Va., 1885, φ having been previously determined from equation (87), page 84:

$$\frac{A(u')-A(V)}{S(u')-S(V)} = \frac{\sin 2\varphi}{G} + I(V)$$

An instrumental velocity at 50 feet from the muzzle of 1,763 feet. giving a muzzle velocity of 1,800 feet, was assumed for the Rubin rifle, This was very nearly the mean velocity obtained in the test for velocity. (See page 5.)

The Frankford cartridges used in the Springfield rifle gave an instrumental velocity of 1,263 feet, and a muzzle velocity of 1,288 feet, and this was assumed in the formula. The computed results as compared with those determined by experiment are given below:

Height of ordinates above line of sight.	Springfield.		Rubin.	
	Measured	Computed.	Measured.	Computed.
	Feet.	*Feet.*	*Feet.*	*Feet.*
100 yards	5.190	5.220	2.886	2.977
200 yards	8.053	8.250	4.514	4.815
300 yards	8.385	8.661	4.816	5.197
400 yards	5.864	6.042	3.484	3.733

Having completed the experiments at the Granby Range, the Board then, at 6 p. m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., October 3, 1888 (9.30 a. m.).

The Board met pursuant to the call of the president. Present, all the members. The recorder submitted to the Board trajectories of the Rubin and Springfield rifles calculated by formulas in Ingalls's Exterior Ballistics for ranges of 500 and 1,000 yards, together with a tracing of the curves, which is herewith submitted marked, E. For the Springfield, the muzzle velocity, 1,315.7 feet, given in the official rules for the management of the Springfield rifle, was assumed. This is somewhat greater than is now obtained with the cartridges made recently at Frankford, those used in the above tests having a muzzle velocity of about 1,288 feet. The Springfield trajectory is therefore computed under the most favorable circumstances as regards velocity. The following are the results obtained. The tracing exhibits the relative flatness of the trajectories, irrespective of the angles of projection.

Range 500 *yards.*

Springfield (angle of projection 1° 8′ 31″).		Rubin (angle of projection 39′ 41″).	
Distance.	Ordinates.	Distance.	Ordinates.
	Feet.		*Feet.*
100 yards	5.081	100 yards	2.977
200 yards	8.036	200 yards	4.815
265.2 yards (maximum)	8.623	273.87 yards (maximum)	5.260
300 yards	8.444	300 yards	5.197
400 yards	5.886	400 yards	3.733

Range 1,000 *yards.*

Springfield (angle of projection 2° 57′ 34″).		Rubin (angle of projection 1° 57′ 01″).	
Distance.	Ordinates.	Distance.	Ordinates.
	Feet.		*Feet.*
100 yards	14.601	100 yards	9.729
200 yards	27.089	200 yards	18.356
300 yards	37.020	300 yards	25.453
400 yards	43.990	400 yards	30.733
500 yards	47.716	500 yards	33.738
546.3 yards (maximum)	48.000	560.11 yards (maximum)	34.263
600 yards	47.421	600 yards	34.031
700 yards	43.054	700 yards	31.208
800 yards	34.101	800 yards	24.895
900 yards	19.861	900 yards	14.612

After discussion the Board decided to fire from a fixed rest one target of thirty shots at the 500-yard range and one target of thirty shots at the 1,000-yard range from the Rubin rifle, and the same from the Springfield rifle, No. 426116, the trial to take place at the first favorable opportunity.

The Board then, at 10 a. m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., October 17, 1888.

The Board met at the call of the president at 10 a. m.

Present, all the members.

The Rubin and Springfield rifles were then fired from the fixed rest at the 500-yard range. Mr. R. T. Hare operated the guns, and one target of 30 shots was fired from each. Springfield rifle No. 426,116 was used, as in the preceding tests for accuracy. The following results were obtained:

Rifle.	Number of shots.	Number of hits.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
			Inches.	*Inches.*	*Inches.*	*Inches.*
Rubin	30	30	7.32	8.28	12.12	12.
Springfield	30	30	8.16	7.35	12.12	10.20

Time of firing each target 30 minutes.

Plots of the targets, showing the position of the shots, are herewith submitted, marked F and G.

The Board then, at 12.45 p. m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., October 22, 1888.

The Board met at the call of the president at 10 a. m.

Present, all the members.

The Rubin and Springfield rifles were then fired from the fixed rest at the 1,000-yard range. Mr. R. T. Hare operated the guns, and one target of 30 shots was fired from each. Springfield rifle No. 426,116 was used, as in the preceding tests for accuracy. The following results were obtained:

Time of firing each target 30 minutes.

Rifle.	Number of shots.	Number of hits.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots (hits).	Radius 50 per cent. of shots.
			Inches.	*Inches.*	*Inches.*	*Inches.*
Rubin	30	30	12.44	15.60	21.60	20.88
Springfield	30	28	12.72	24.	29.46	25.20

Plots of the targets, showing the position of the shots, are herewith submitted, marked H and I.

The Board then, at 12.45 p. m., adjourned to meet at the call of the president.

NATIONAL ARMORY,
Springfield, Mass., January 16, 1889.

The Board met at the call of the president at 10 a. m.

Present: All the members.

The recorder submitted to the Board a drawing of the Rubin rifle and description of the same, which are herewith submitted, marked K and L. The recorder stated that owing to the great press of work, the Armory draughtsman had been unable to complete the drawing at an earlier date.

In conclusion the Board would state that the Rubin magazine rifle has passed all the tests to which it has been subjected in a very satisfactory manner. The repeating mechanism has performed its functions perfectly. No difficulty in extracting cartridge shells has been experienced and the few misfires noted were owing to a deficiency of fulminate in the primers. As a comparative test affords the best means of determining the merit of an arm, in most of the trials the service Springfield rifle was fired in competition with the Rubin. The following is a summary of the results:

(1) The initial velocity of the Rubin is 500 feet greater than that of the Springfield.

(2) The recoil of the Rubin in foot pounds is half that of the Springfield.

(3) The penetration of the Rubin in white pine is 1.38 times that of the Springfield at 500 yards, and 1.25 times that of the Springfield at 1,000 yards.

(4) The trajectory of the Rubin is much flatter than that of the Springfield, as shown by the diagram submitted, and gives a largely increased dangerous space.

(5) The two guns differ little in accuracy at the 500-yard range, but the Rubin is decidedly superior at the 1,000-yard range.

The record of the Rubin rifle for rapidity compares as follows with that of the three arms recommended by the Magazine-gun Board of 1881. All four arms were operated in this test by Mr. R. T. Hare.

Rapidity with accuracy as magazine gun.

Rifle.	Date of firing.	Firer.	Shots.	Hits.
Lee	July 11, 1882	R. T. Hare	41	27
Chaffee-Reece	June 15, 1882	....do	38	25
Hotchkiss	June 27, 1882	....do	81	14
Rubin	Aug. 21, 1888	....do	39	34

Rapidity with accuracy as single loader.

Lee	July 11, 1882	R. T. Hare	46	31
Chaffee-Reece	June 15, 1882	....do	41	15
Hotchkiss	June 27, 1882	....do	45	21
Rubin	Aug. 21, 1888	....do	32	82

Rapidity at will as magazine gun.

Lee	July 11, 1882	R. T. Hare	35	....
Chaffee-Reece	June 15, 1882	....do	23	....
Hotchkiss	June 27, 1882	....do	23	....
Rubin	Aug. 21, 1888	....do	25	....

Rapidity at will as single loader.

Lee	July 11, 1882	R. T. Hare	29	....
Chaffee-Reece	June 15, 1882	....do	26	....
Hotchkiss	June 27, 1882	....do	31	....
Rubin	Aug. 21, 1888	....do	22	....

The Rubin cartridges which missed fire were found to be deficient in fulminate. The lubricant used on the bullet is considered objectionable by the Board, as in using the gun as a single loader it is transferred to the fingers of the operator and affects his manipulation of the gun. Loose cartridges are apt to become covered with dirt and grit, and have to be carefully wiped before being inserted in the chamber. No trouble was experienced with the ring used to fill up the space between the bullet and cartridge case. In no case was it driven into the rifling. No primer piercing was noted.

The unusual "creep" of the trigger pull which was much complained of by the experts operating the gun, and the crudeness of the rear sight, doubtless injuriously affected the record of the gun for accuracy. With a Buffington sight and a service trigger it is probable that much better targets can be made. The limited number of cartridges (500) at the disposal of the Board, of course prevented a thorough test of the gun. An endurance test of 500 rounds, which the Board regards as especially important, was therefore impracticable.

There being no further business before it the Board then, at 11 a. m., adjourned *sine die*.

W. A. MARYE,
Major of Ordnance, U. S. Army.
J. C. CLIFFORD,
Captain, Ordnance Department.
CHARLES H. CLARK,
Lieutenant of Ordnance.
J. W. BENÉT,
Lieutenant of Ordnance, Recorder.

Approved:

A. R. BUFFINGTON,
Lieutenant-Colonel, Ordnance.

DESCRIPTION OF THE RUBIN MAGAZINE RIFLE.

A drawing herewith submitted, marked K, shows the rifle in section (breech opened) and largely in detail.

The principal parts of the breech mechanism are: (1) the receiver or breech case A; (2) the breech-bolt B; (3) the sear C; (4) the sear and bolt stop spring D; (5) the trigger E; (6) the bolt stop F; (7) the cut-off mechanism (not shown in drawing); (8) the magazine G.

The receiver A has a vertical slot cut entirely through it for the purpose of receiving cartridges from the magazine. The receiver is also bored through longitudinally for the reception of the breech-bolt, and is cut away at the right side to allow facility of loading and to admit of easy ejection of cartridge shells. The ejector stud m assists in the ejection. Two grooves are provided in which the extractor and guide rib slide as the bolt is pushed back and forth. Three projections and three recesses are formed in the rear interior surface of the receiver into which, when the bolt-handle is turned down, the corresponding recesses and projections on the exterior of the locking-tube lock. The extractor is received in a recess in the forward end of the receiver. The bolt guide-piece n, is a prolongation of the lower rear part of the receiver and has a groove in which the bolt guide lug and firing-pin lug move.

The breech-bolt, B, is made up of the following parts: (1) the breech-bolt proper a; (2) the spring extractor b; (3) the locking-tube and bolt-handle c; (4) the firing-pin and lug d; (5) the mainspring e; (6) the mainspring cover f; and (7) the locking nut g.

The breech-bolt proper a, is hollowed out for the firing-pin, and a vertical slot, a_1, is cut through the rear portion, in which the firing-pin lug moves. A screw thread, a^3, is cut on the bolt in rear of the extractor which receives a thread cut on the interior of the locking tube. Another screw thread, a_3, is cut near the extreme end of the bolt to receive the locking nut. A guide rib, a_4, projects from the left side of the bolt, which acts as a guide and also operates the repeating mechanism when the magazine is not cut off by striking the cut-off cam as the bolt is moved backward thus causing the cut-off to move to the left and allow a cartridge to come up from the magazine. The ejector-stud groove in the lower surface of the bolt receives the ejector stud when the bolt is moved.

The spring extractor, b, is pinned at its middle to the breech-bolt proper, and rocks about this pin, b_1; it is attached at its rear end to the breech-bolt proper, over which connection the locking-tube screws.

The locking-tube and bolt-handle, c, form a single piece. The locking-tube is hollowed out and a thread, c_1, is cut on the interior which locks with the screw thread cut on the breech-bolt proper. Three projections and three recesses, c_2, are formed on the exterior forward end of the locking-tube, which lock into the corresponding recesses and projections of the receiver, when the bolt handle is turned down. The guide, c^3, on the lower exterior surface runs in the groove of the bolt guide-piece. A cut, c_4, is made in the locking-tube in which the firing-pin lug rests when the piece is discharged.

The shape of this cut is such that when the bolt-handle is raised the firing-pin lug is cammed back and the point of the firing-pin withdrawn within the breech-bolt. As the lug is cammed back it compresses the mainspring against the locking-nut, but is supported against the pressure of the mainspring by the locking-tube and sear. The bolt-handle shoulders c_5 serve to limit the motion of the bolt.

The firing-pin and lug are in one piece, d, and two recesses are cut in the lug to receive the mainspring. By the action of the trigger when the bolt is in the firing position and the lug unsupported by the locking-tube, the sear is made to release the lug, and the mainspring acts, pushing forward the firing-pin which strikes the cartridge. The mainspring e is shorter than in most bolt guns and is made of thick wire; it gets a bearing in front against the firing-pin lug, and in rear against the locking-nut.

The mainspring-cover f covers the mainspring and has a slot, f_1, in which the firing-pin lug moves. The cover spring f_2 and stop f_3 help to lock the parts of the breech-bolt together, the spring pressing the stop into a hole g_1 in the locking nut. A screw, f_4, fastens the cover-spring to the cover. The locking nut g, which is provided with a milled head, g_2, is perforated for the firing-pin. It locks with the screw thread on the rear of the locking tube. The bolt stop F is attached to the bolt guide-piece and when pressed down allows the bolt to be withdrawn. The sear and bolt-stop spring D acts as a bolt-stop spring as well as a sear spring, and when the action of the trigger frees the sear from the firing-pin lug, the stop, if turned down, is automatically thrown up by the spring. The sear C abuts against the firing-pin lug and supports it against the pressure of the mainspring.

The trigger E performs the usual functions of a trigger. The cut-off mechanism consists of the cut-off, the cut-off spring, the indicator thumb-piece, the cut-off cam, and the cut-off cam-spring. The cut-off extends over the left upper surface of the magazine, and when in position prevents cartridges from feeding up. It carries below a flat spring, the cut-off spring, which keeps it in position. The indicator thumb-piece stem passes through the cut-off cam and the cam revolves about it. The cut-off cam-spring keeps the cam in its proper position. When the indicator thumb-piece is turned with the R to the front, the cam enters a cut in the receiver and is struck by the guide rib as the bolt moves back and forth. By the action of the cam, the cut-off is moved to the left and the repeating mechanism allowed to act—feeding up a cartridge as the bolt is moved backward. The magazine G is underneath and in front of the trigger-guard and holds seven cartridges. It resembles that of the Lee gun, but is fixed to the receiver. It consists of the magazine proper, *y*, fastened to the receiver, the magazine bottom y_1 screwed to the stock by the two screws y_2, the magazine spring y_3, and the follower y_4.

To load the arm, the bolt being open, in which case the firing-pin is cocked, and its lug abuts against the locking-tube and sear, insert a cartridge in the receiver and push the bolt home, forcing the cartridge into the chamber. Then turn down the bolt-handle till the right shoulder strikes the bolt guide-piece. The locking-tube is now locked into the receiver and the firing-pin lug is opposite the cut in the locking-tube and is only supported by the sear. Turning down the bolt-handle slightly unscrews the locking-tube from the breech-bolt, and allows the bolt to move forward a little, thus supporting the head of cartridge. The spring extractor at the same time rises. Pulling the trigger releases the sear from the firing-pin lug and allows the mainspring to act on the firing-pin which moves forward and explodes the cartridge.

As the bolt handle is raised, the firing-pin lug is cammed back as before explained and is supported at the completion of the motion by the locking-tube and sear. The locking tube is screwed home on the breech-bolt as the handle rises, moving the bolt slightly to the rear and causing the spring extractor to move downwards and start the shell. Moving back the bolt extracts the shell which strikes the ejector stud and is ejected. If the magazine is not cut off pushing back the bolt will feed up a cartridge from the magazine.

There is no half-cock or safety arrangement, and the magazine can only be loaded with the bolt open.

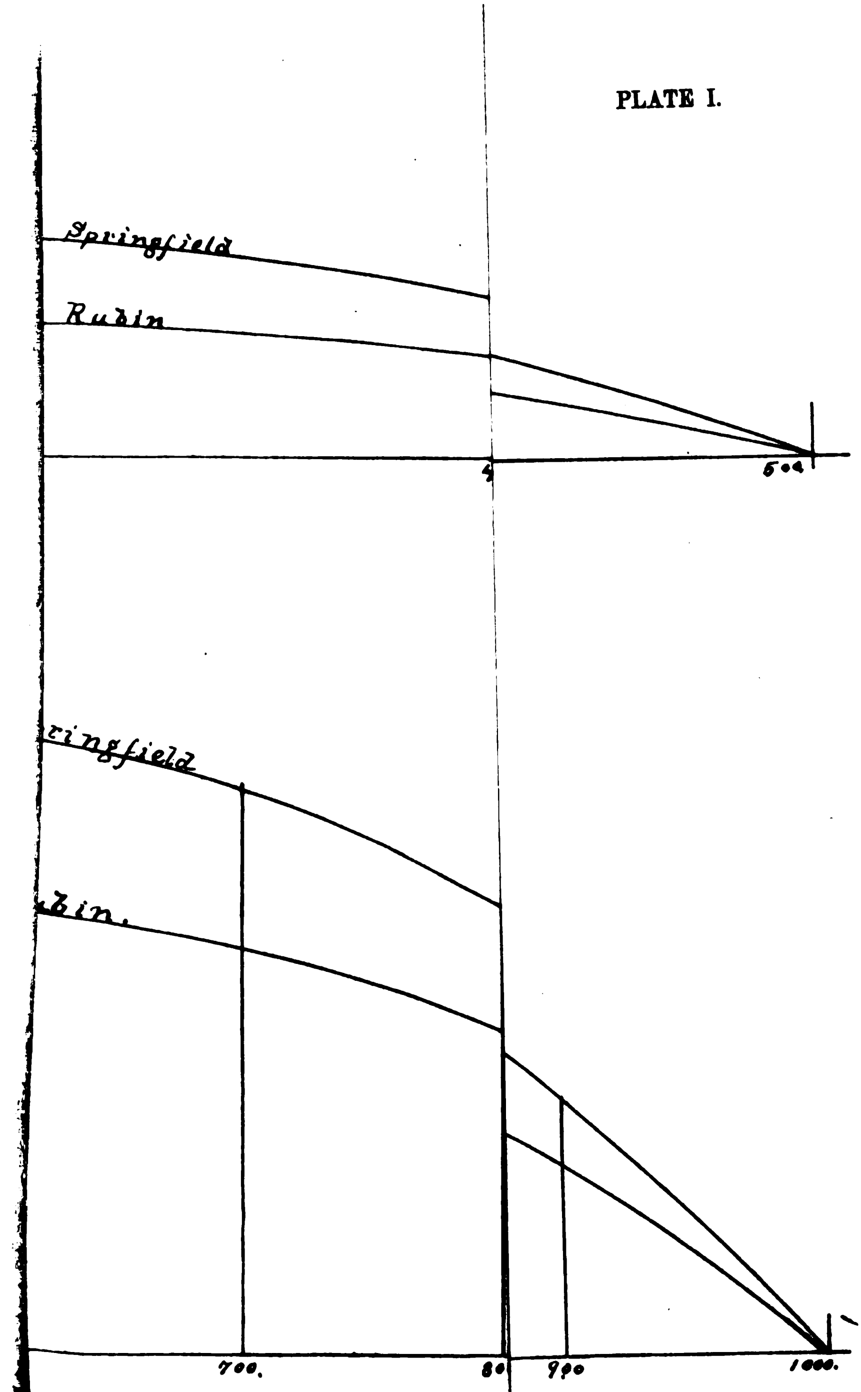
The barrel is chambered to receive the Rubin cartridge.

Length of barrel, 30.85 inches; number of grooves, 3; width of grooves, .1549 inch; width of lands, .1549 inch; depth of grooves, .0065 inch; twist of rifling, one turn in 10.625 inches; caliber, .29529 inch.

The Rubin cartridge case is tapering, with thick walls, and is made of brass and outside primed. It is provided with an inner ring which fills up the space between the forward part of the case and the projectile. The case is unflanged, and instead a groove is cut around the base in which the extractor engages. The bullet is lead, jacketed with copper, and the head is not "cut off" as in the Lorenz bullet. The charge of powder used is 69.48 grains and the weight of the projectile is 217 grains. Compressed powder having a central perforation is used. The bullet is lubricated.

The cartridges are put up in tin cases, holding seven cartridges. The tin case is enclosed in a pasteboard case, which is covered with paper and tied with string. The tin case is placed over the magazine, and by the pressure of the fingers the seven cartridges are stripped into the magazine at one motion. The cases are cheap and can be thrown away.

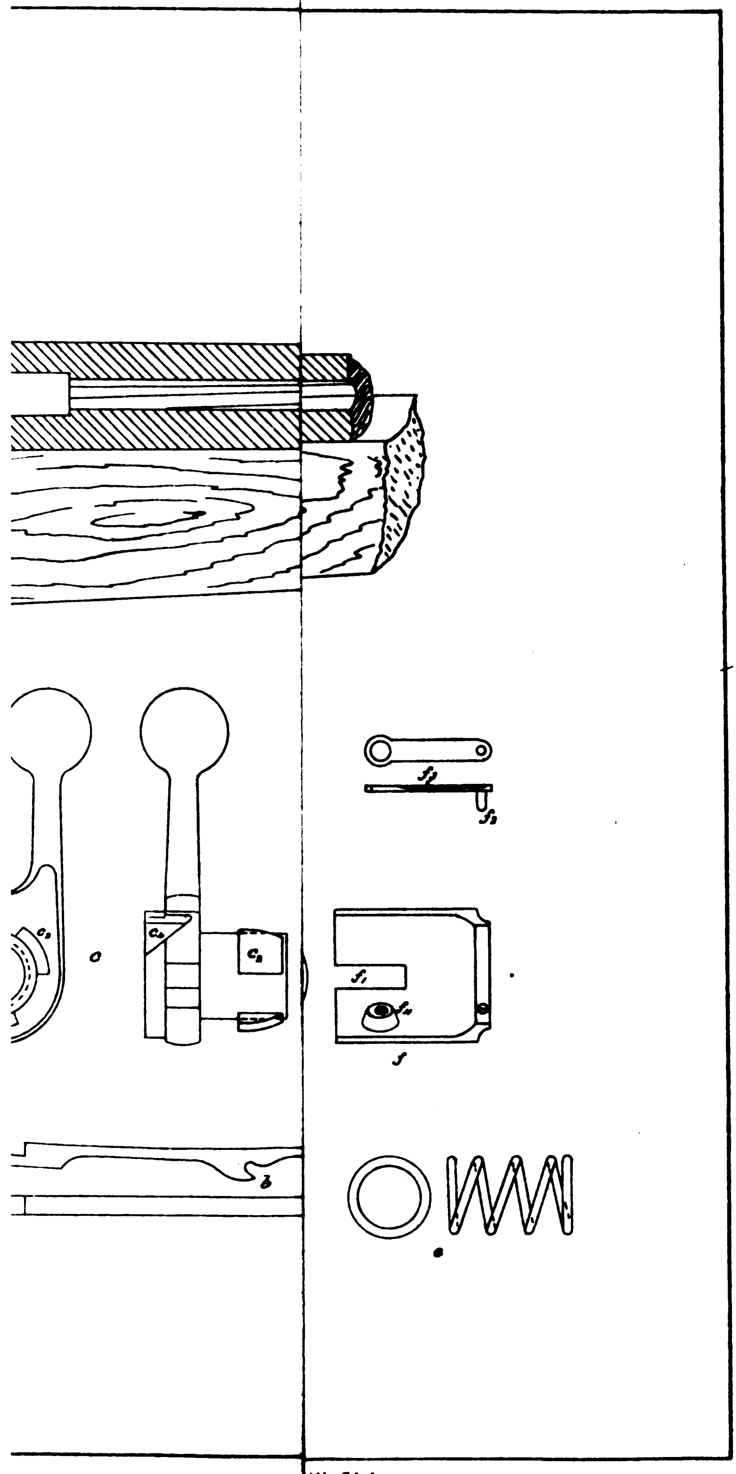
PLATE I.



War51 1

Projected to show "flatness" irrespective of their range

Appendix 10, 1889.



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APPENDIX 11.

TRIAL OF THE SCHULHOF MAGAZINE RIFLE.

(2 plates.)

Report of a Board convened at the National Armory, Springfield, Mass., to test and report upon a Schulhof magazine rifle, pursuant to the following indorsement:

[Third indorsement, O. O. File, No. 8348, 1888.]

NATIONAL ARMORY,
Springfield, Mass., August 29, 1888.

Respectfully referred to the Board of which Maj. W. A. Marye is president. When Mr. Schulhof's rifle and ammunition are received, a thorough test of the rifle will be made, using the test of the last Magazine Gun Board. Velocity, pressure in chamber, penetration at 500 and 1,000 yards, and trajectories at these ranges will be ascertained and made.

A. R. BUFFINGTON,
Lieutenant-Colonel of Ordnance, Commanding.

NATIONAL ARMORY,
Springfield, Mass., January 12, 1889.

The Board met pursuant to verbal order from the commanding officer National Armory at 10 a. m. Present: All the members. The Schulhof magazine rifle tested by the Board on December 18, 1888, was resubmitted to the Board by the commanding officer National Armory. This rifle, as stated in the progress report previously submitted, was disabled by the bolt handle becoming detached from the bolt to which it had been attached simply by brazing. Since the previous trial the bolt-handle had been re-brazed at this Armory and its attachment to the bolt further strengthened by the addition of three pins. No further difficulty was experienced with it in the succeeding tests. The Board then proceeded to subject the rifle to the required tests as follows:

RAPIDITY WITH ACCURACY.

The number of shots which, fired in two minutes from the gun, both as a magazine gun and as a single loader, strike a target 6 feet by 2 feet at a distance of 100 feet. Any cartridges missing fire in this or other tests to be tried with a prick punch or opened to ascertain the cause of failure. The test to be begun with the chamber or magazine filled; other cartridges to be disposed at will on a table. Gun operated by Mr. R. T. Hare.

As magazine gun: Forty-two shots, twenty-nine hits. The magazine was refilled during the firing from the tin cartoons.

As a single loader: Forty-three shots, nineteen hits.

The magazine was then loaded, using a cartoon, and the 9 cartridges fired. Time for whole operation, 12¼ seconds. Nine cartridges were then fired, using the gun as a single loader and taking the cartridges from a table. Time, 15½ seconds. The gun was then fired 20 rounds as a single loader for rapidity with accuracy. Nine hits. Time, 51¾ seconds. The magazine was then filled and cut off, 12 rounds fired as a single loader, and the magazine then turned on and emptied. Twelve hits. Time, 42⅝ seconds.

RAPIDITY AT WILL.

The number of shots which can be fired in one minute, irrespective of aim, under the same circumstances as in test for rapidity with accuracy:

As magazine gun: Twenty-nine shots (using cartoons).

As single loader: Twenty-eight shots; 1 missfire owing to bolt not being fully closed; 2 cartridges dropped in loading.

As magazine gun (loading magazine with loose cartridges, using fingers): Twenty-six shots. Time, 48⅜ seconds. Supply of cartridges on firing ground exhausted.

The Board then, at 3 p. m., adjourned to meet at 10 a. m., the 14th instant.

NATIONAL ARMORY,
Springfield, Mass., January 14, 1889.

The Board met pursuant to adjournment at 10 a.m. Present: All the members.

The tests were continued as follows:

ENDURANCE.

The gun to be fired 400 continuous rounds without cleaning, using the magazine. The state of the breech mechanism to be examined at the end of every 50 rounds. Water was passed through the barrel to cool it after each 50 rounds.

First 50 rounds: Gun worked well.

Second 50 rounds: Gun worked well.

Third 50 rounds: Bolt worked very hard, requiring the use of both hands at times. Liberal escape of gas from badly cracked cartridge shell.

Fourth 50 rounds: Bolt worked very hard, the manipulation gradually becoming easier as the gun grew more heated. Large escape of gas from badly cracked shell.

Fifth 50 rounds: Same remarks as before as to working of bolt.

Sixth 50 rounds: Both hands required to work bolt till gun became heated up.

Seventh 50 rounds: Gun worked hard as before. Escape of gas from badly cracked shells.

Eighth 50 rounds. Bolt worked with great difficulty. Escape of gas from cracked shell.

The bolt was carefully examined after this test and was found to be sprung and upset, which accounted for the difficulty experienced in manipulating it. Very little fouling was found in the barrel. No miss-fires and no failures to extract occurred in this test. The Board decided to have the bolt straightened and then to continue the tests.

The Board then, at 12 m., adjourned to meet at 10 a. m., the 16th instant.

NATIONAL ARMORY,
Springfield, Mass., January 16, 1889.

The Board met pursuant to adjournment at 10 a.m. Present: All the members.

The tests were continued as follows, the bolt having in the mean time been straightened by hammering on a lead block:

DEFECTIVE CARTRIDGES.

The gun to be fired once with each of the following defective cartridges: (1) Cross filed on head to nearly the thickness of the metal; (2) cut at intervals around the rim; (3) with a longitudinal cut the whole length of the cartridge, from the rim up; a fresh piece of white paper being laid over the breech to observe the escape of gas.

No. 1. Paper badly torn; magazine gate blown open; liberal escape of gas to side.

No. 2. Paper badly torn; less escape of gas than in the preceding.

No. 3. Paper slightly torn; small escape of gas.

As there was a possibility of the gun being disabled in the succeeding tests, the Board decided to postpone these until the gun had been thoroughly tested for velocity, pressure in chamber, accuracy, and penetration at 500 and 1,000 yards. The Board thought it best to keep no further daily record of meetings and adjournments, but to carry on the tests whenever the weather and other conditions were most favorable. Some of these tests had already been made previous to the disabling of the gun on December 18, 1888.

VELOCITY.

This was determined on December 10, 1888. The instrument used was a Le Boulengé chronograph, which was operated by R. T. Hare and the recorder. Distance between targets, 100 feet. Thermometer, dry bulb, 31°; wet bulb, 32°. Barometer, 29.84.

Number of shot.	Instrumental velocity.	Number of shot.	Instrumental velocity.	Number of shot.	Instrumental velocity.
1	1846.7	5	1841.5	8	1811.6
2	1826.4	6	1862.1	9	1828.1
3	1862.1	7	1810.0	Mean	1835.9
4	1834.7				

RECOIL.

The recoil of the Schulhof rifle, as compared with that of the Springfield, was determined on the same date by the recoil dynamometer, described in Ordnance Notes 31 and 32.

Number of shot.	Recoil in foot-pounds.	Number of shot.	Recoil in foot-pounds.	Number of shot.	Recoil in foot-pounds.
1	6.25	3	6.25	5	6.50
2	6.00	4	6.50	Mean	6.30

Recoil of Springfield in foot-pounds, 12.90; determined August 22, 1888.

PRESSURE.

On December 10, 1888, a Hebler cartridge was fired in the small-calibre barrel and housing used for the purpose of determining pressures. The pressure obtained was 40,000 pounds. As it is necessary to cut a hole in the cartridge shell to provide for the access of the powder gas to the piston of the pressure-gauge, and, as this cutting is attended with considerable danger to the workman, no more cartridges were prepared for taking pressures.

ACCURACY.

The Schulhof rifle was fired as follows for accuracy, a fixed rest being used, and the gun in each case being operated by Mr. R. T. Hare. The Springfield rifle was fired under the same circumstances to afford a comparative test. The shots were recorded by means of a camera, by the method explained in Appendix A, Report of Chief of Ordnance, 1882.

December 13, 1888.—Distance, 500 yards. Thermometer, wet bulb, 19°; dry bulb, 23°. Barometer, 29.74. Number of shots, 20. Number of hits, 20.

Gun.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
Schulhof	4.98	10.68	13.05	11.52
Springfield	4.74	5.28	9.18	8.88

(Plots of the above targets are herewith submitted, marked A and B.)

January 3, 1889.—Distance, 500 yards. Thermometer, wet bulb, 38.5°; dry bulb, 44.0°. Barometer, 30.03. Number of shots, 20. Number of hits, 20.

Gun.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
Schulhof	6.48	8.40	12.36	10.80
Springfield	2.64	4.80	5.82	4.80

(Plots of the above targets are herewith submitted, marked C and D.)

January 4, 1889.—Distance, 1,000 yards. Thermometer, wet bulb, 38°; dry bulb, 41°. Barometer, 30.12. Number of shots, 20. Number of hits, 20.

Gun.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
Schulhof	10.80	26.94	30.84	25.68
Springfield	12.36	18.78	23.92	21.84

(Plots of the above targets are herewith submitted, marked E and F.)

January 14, 1889.—Distance, 1,000 yards. Thermometer, wet bulb, 31.0°; dry bulb, 35.0°. Barometer, 30.21. Number of shots, 20. Number of hits, 20.

Gun.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*
Schulhof	12.96	27.60	32.16	28.80
Springfield	10.80	38.40	40.80	33.84

(Plots of the above targets are herewith submitted, marked G and H.)

PENETRATION.

January 7, 1889.—The target used to test penetration was composed of twenty-four white pine boards 1 inch thick, placed 1 inch apart to facilitate tracing the course of the bullets.

The penetration obtained was as follows:

Number of shot.	Penetration.	
	500 yards.	1,000 yards.
	Inches.	*Inches.*
1	15.25	10.00
2	14.50	9.25
3	14.50	9.50
4	14.75	9.50
5	15.50	10.25
6	15.50	9.50
Mean	15.00	9.66

The Magazine-gun Board tests were then continued as follows:

EXCESSIVE CHARGES.

After discussion the Board decided by a majority vote to submit the gun to the following test:

The gun to be fired five rounds with Hebler cartridges in which the charge of powder had been increased by filling the fire channel in the compressed powder-cake with 8 grains of Hazard No. 2 duck-shooting powder. One of these cartridges was inserted in the chamber and the other four placed in the magazine. On firing the gun the head was blown off the cartridge in the chamber, and one of the cartridges in the magazine exploded, being probably ignited through a crack in the metal of the cartridge case. These cracks were very frequently met with in the Hebler cartridges used in the tests. Two of the other cartridges in the magazine were blown out unexploded, the magazine gate was blown open and badly bent, and the bolt was again upset and sprung. The gun was too much disabled to allow the tests to be continued, and the board decided to have it repaired before proceeding further. One of the prepared cartridges which had been in the magazine at the time of the explosion was fired in the housing used for taking pressures, and one of the ordinary Hebler cartridges was fired for pressure in comparison. The results were as follows: Length of cut, prepared cartridge, 1.039 inches; ordinary cartridge, .947 inch. Coppers of the same lot of metal as those used to obtain the above cuts were sent to the Watertown Arsenal for trial in the United States testing machine, and it was found that a length of cut of 9.61 inches corresponds to pressure of 41,000 pounds, and a length of cut of 1.029 inches corresponds to a pressure of 50,000 pounds. Therefore the prepared cartridge developed a pressure at least 10,000 pounds greater than is obtained with the ordinary Hebler cartridge.

The tests were resumed on January 21, 1889, the bolt having been straightened as before, and the magazine gate put in working order. It was found that the bolt had been so upset as to shorten it appreciably, increasing the head space and leaving the cartridge unsupported.

DUST.

The piece to be exposed, in the box prepared for that purpose, to a blast of fine sand dust for two minutes, to be removed, fired 20 rounds, replaced for two minutes, removed and fired 20 rounds more. The piece was subjected to the first dusting and fired 6 rounds. The heads of the first two cartridges fired were blown off. The next three were lubricated and worked satisfactory. On the sixth round an escape of gas took place, the cartridge shell being badly cracked near the base. The extractor was broken in two pieces and blown to some distance and the magazine gate was blown open. The magazine worked perfectly throughout this test. As the gun was disabled by the breaking of the extractor it was necessary to suspend the tests till a new extractor could be made.

The tests were resumed on February 14. The gun had in the meantime been repaired as follows: A new extractor, made at this armory, had been substituted for the one broken in the dust test, and the bolt had been lengthened by the addition of a new piece, in order to support the cartridge properly and preserve the proper head space.

The tests were then continued as follows:

RUST.

The breech mechanism and receiver to be cleansed of grease and the chamber of the barrel greased and plugged, the butt of the gun to be inserted to the height of the chamber in a solution of sal-ammoniac for ten minutes, exposed for two days in a warm room, and then fired 20 rounds. Gun well rusted. Great difficulty was experienced in working the bolt, and it was taken out and the firing-pin notch rubbed clean of rust. The bolt was then replaced and found to work much better. The 20 rounds were fired without difficulty, the magazine and cut-off, which were very thoroughly rusted, working well after a little manipulation. When only one or two cartridges remained in the magazine, it was found that the magazine spring had not power to feed them up, and had to be aided by rapping with a mallet.

TRAJECTORY.

On February 6 the Board decided to determine the trajectory of the Schulhof-Hebler rifle for 500 yards practically by the use of paper screens. The 500-yard range at the Water Shop Pond was used, and paper screens were established on the ice at 100, 200, 300, and 400 yards from the firing point.

The following measurements were made:

	Feet.
Bottom line of 500-yard target above ice	5.5427
Muzzle of gun above ice (fixed rest used)	5.112

A high wind was blowing, and although 12 shots were fired, none of them passed through all the screens. On February 11 the experiment was repeated, and after 15 unsuccessful shots, one was finally obtained which passed through all the screens and struck the target.

Shot struck—	Above ice.	Above muzzle of gun.
	Feet.	*Feet.*
100-yard screen	8.908	3.796
200-yard screen	11.604	6.492
300-yard screen	12.983	7.871
400-yard screen	12.579	7.467
Target	9.959	4.847

This gives for the approximate height of the trajectory above the line of sight—

	Feet.
100 yards	2.826
200 yards	4.553
300 yards	4.962
400 yards	3.589

Inasmuch as it had required two entire days' labor and the expenditure of nearly 30 rounds of ammunition to get one shot through all the screens, the Board decided not to continue this experiment further.

The ordinates of the trajectory of the Schulhof-Hebler rifle were then calculated by the recorder for ranges of 500 and 1,000 yards, using the formulas on page 84, "Exterior Ballistics," by Capt. J. M. Ingalls, Fort Monroe, Va. An instrumental velocity at 50 feet from the muzzle of 1,836 feet, giving a muzzle velocity of 1,873 feet, was assumed. This was very nearly the mean velocity obtained in the test for velocity.

Range 500 *yards.—Angle of projection* 36′ 45″.

ORDINATES.

	Feet.
100 yards	2.759
200 yards	4.464
274.335 yards (maximum)	4.880
300 yards	4.827
400 yards	3.485

Range 1,000 *yards.—Angle of projection* 1° 50′ 14″.

ORDINATES.

	Feet.		Feet.
100 yards	9.174	562.938 yards (maximum)	32.587
200 yards	17.294	600 yards	32.421
300 yards	24.070	700 yards	30.102
400 yards	29.141	800 yards	23.782
500 yards	32.065	900 yards	13.993

The Schulhof breech mechanism was fully described in the pamphlet submitted with the previous reports of the Board.

The Hebler cartridge used resembles in general the one described in Notes on the Construction of Ordnance, No. 43.

Appendix: The weight, dimensions, charge, etc., differ as follows: Length of cartridge case, 2.015 inches; length of cartridge, 2.956 inches; weight of cartridge (average) 386 grains; powder charge, 57 to 60 grains; weight of bullet, 215 grains.

NATIONAL ARMORY,
Springfield, Mass., March 6, 1889.

The Board met pursuant to the call of the president at 2 p. m. Present, all the members except Lieutenant Clark, who was on leave of absence for one month, authorized by letter of Chief of Ordnance, dated February 25, 1889.

After discussion, the Board decided that in the present condition of the gun it was not advisable to submit it to further tests.

After a careful review of the preceding trials, the Board would submit the following report: The tests to which the Schulhof rifle has been subjected have been unusually severe, owing to the defective nature of the Hebler cartridges used. Cracks were developed in more than 50 per cent. of the cartridge cases, and the escape of gas in many cases was excessive. The breech-bolt, in the opinion of the Board, does not possess the necessary strength and solidity. It is a mere shell, and is liable to become so sprung and upset by repeated firing as to prevent its proper working. This bolt was practically disabled after the endurance test, and had to be straightened and repaired several times during the trials. The attachment of the bolt handle to the bolt by brazing alone is, in the opinion of the Board, very objectionable. The gun was disabled in the first trial by the bolt handle becoming detached from the bolt. It was rebrazed and in addition pinned to the bolt, and no further trouble was experienced. The extracting and firing mechanisms worked well throughout the tests, no miss-fires nor failures to extract being noted. The performance of the magazine and cut-off was perfectly satisfactory. It was found that greater rapidity of fire could be obtained when loose cartridges were loaded into the magazine by the fingers, than when the tin cartoons were used. In the opinion of the board this magazine excels in the ease and rapidity with which it can be loaded with loose cartridges. It also possesses the advantage of being loaded with equal facility, whether the bolt is opened or closed. Although more complicated than some others, its mechanism was unimpaired by the different tests, including the severe rust test.

The "excessive charge" test, in which the gun was disabled, should not be considered, as the pressure developed was abnormal, and the whole test one that no arm should be expected to stand. The explosion of the cartridge in the magazine was due, the Board thinks, to a crack in the metal of the cartridge case, which allowed the ignition of the cartridge. In any other form of magazine it is probable that the same accident would have occurred under the same conditions.

To sum up, the Board is of the opinion the Schulhof magazine has passed the tests to which it has been subjected in a satisfactory manner. The working of the firing and extracting mechanisms was satisfactory through the tests. The bolt as now constructed the Board regards as weak and unsatisfactory and not suitable for a military arm.

The Board considers the Hebler cartridges to be dangerous and unsuitable for the military service. More than 50 per cent. of the shells fired were found to be cracked, and the escape of gas throughout the tests was frequent and very detrimental to the arm. The practice for accuracy was much inferior to previous practice with the Rubin cartridges, and the variation in velocity seemed to be considerable.

There being no further business before it the Board then, at 4 p. m., adjourned *sine die.*

W. A. MARYE,
Major of Ordnance, U. S. Army.
J. C. CLIFFORD,
Captain, Ordnance Department.
J. W. BENÉT,
Lieutenant of Ordnance, Recorder.
SAM'L W. PORTER,
Master Armorer.

Approved.
A. P. BUFFINGTON,
Lieutenant-Colonel, Ordnance.

REPEATING CARBINE SYSTEM, JOSEF SCHULHOF, MODEL 1888.

The principal parts of this new repeating carbine are the following:

I. The breech-frame and breech-case with stock and barrel.
II. The breech-bolt with firing-pin and spring.
III. The locking-block with operating lever and spring.
IV. The trigger and trigger spring.
V. The magazine.

In the annexed drawings the carbine and its different parts are represented.

Figure 1 shows the carbine seen from the left.
Figure 2 is a left side view of the mechanism of the carbine with breech closed.
Figure 3 is the same view with open breech.
Figure 4 shows in five views the breech-bolt.
Figure 5 shows the firing-pin and spring.
Figure 6 shows the rear end of the breech-bolt, indicating position of firing-pin when cocked.
Figure 7 shows in three views the breech-block and its two pivots.
Figure 8 is a top view of the magazine detached.
Figure 9 is a rear view of the magazine with closed door.
Figure 10 is the same view with opened door.
Figure 11 is a front view of the magazine.

The frame of the carbine is open at the sides and carries the breech-case *a*, which is above provided with the cartridge receiving and ejecting opening as in other firearms with sliding breech-bolt.

The breech-bolt consists of but three principal parts, the bolt proper *b*, the firing-pin *e*, and firing-spring *f*. The breech-bolt slides or reciprocates in the breech-case and is below provided with a lug, b^1, to which is pivoted the breech-block *c* by means of the loosely-inserted pin c^1. Block *c* is forked or provided with a slit, c^2, into which fits the top part of operating lever *d*. This top part of lever *d* has a curved or angular slit, d^2, through which, and through a hole in block *c*, a screw, d^3, is passed, thereby moveably jointing together block *c* with operating lever *d*. Lever *d* is at d^1, pivoted in the frame and is below provided with the operating ring d^4. Operating lever *d*, block *c*, and breech-bolt *a* being connected in the manner described, it follows that when a reciprocating movement is given to operating ring d^4, the same movement, but in an opposite direction, is imparted to the breech-bolt; that is, pulling back ring d^4, will close the breech-bolt, and pushing it forward will open it. When the breech-bolt is closed block *c* is in a horizontal position, as shown in Figure 2, and its rear end rests against a shoulder, a^2, of the breech-case, thereby blocking the breech-bolt when the shot is fired. As the opening of the breech-bolt with the finger, by pushing forward ring d^4 of the operating lever, would be difficult and tiresome, this movement is caused by a strong spring, *g*, attached to the stock-plate by a screw, g^1. Spring *g* presses upon a small roller, d^5, attached to operating lever *d* in such manner that when the latter is pulled back by ring d^4 spring *g* is raised and tightened. When lever *d* has arrived in a vertical position, the breech-bolt being closed, as shown, the force of spring *g* is in line with pivot d^1 of lever *d*, and consequently can not act. As soon, however, as a slight forward impulse is given by the operating finger to ring d^4, spring g comes into action, and in forcing the lower part of lever d forward, naturally opens the breech-bolt. Firing-pin e, upon which spring f is coiled, slides in the breech-bolt, where it is guided in a plug, e^1, which is screwed into the rear end of breech-bolt b.

The rear end of firing-pin e is provided with a knob, e^2, to which a guide bar, e^3, is attached. This guide bar e^3 slides in a grove b^2 underneath the breech-bolt. *The trigger mechanism* consists of the trigger proper h, which fits into the slit in the operating ring d^4, and which is pivoted in the frame upon a pin h^1. The top arm of trigger h carries the sear h^2 and is pressed upon by trigger spring h^3.

In closing the bolt the forward end of guide-bar e^3 is caught by sear h^2 and thereby the firing-pin is arrested and its spring compressed or cocked as the breech-bolt advances.

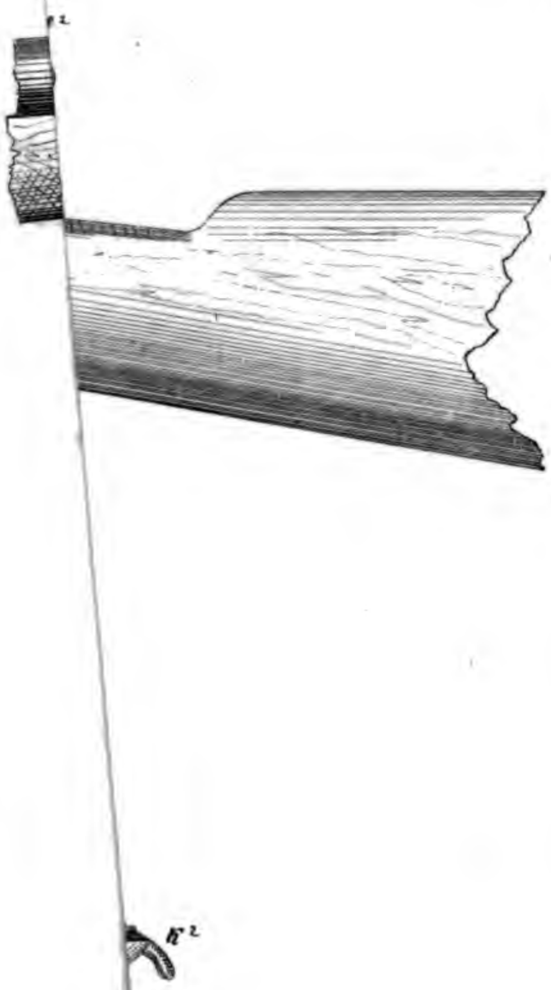
The frame of the carbine is closed on either side by a plate or cover, i, i^1, the one of which is fastened by a screw, while the other is held in place by a turn button or latch i^3, so that this one side plate may be removed without the aid of tools. The magazine is a drum, rigidly attached below the breech opening to the breech-case; said magazine drum k is accessible by a flap or door, k^1, which is kept closed by a snap bolt, k^2. Inside the magazine drum k is placed the rotary drum or shaft l to which the cartridge feeder l^1 is attached. Feeding drum l is rotated by a spiral spring m, coiled upon its forward end and attached with one end to the magazine and with the other to drum or shaft l. The rear end of shaft l is cogged or provided with teeth, n^1, into which gears a cogged segment, n, pivoted upon the rear end of magazine drum k. When flap or door k^1 is opened it strikes and carries along segment n, giving it about one-fourth turn which results in about one whole turn of shaft l, whereby spring m is wound or tightened. When door k^1 has been completely opened, segment n has been carried somewhat beyond its proper gearing position to teeth n^1, so that its last tooth acts as a kind of brake to shaft l and thereby prevents it from turning back under the influence of the coiled spring.

The cartridges having been introduced into the magazine the door is again closed, and in so doing strikes against segment n, thereby throwing it into proper gear again with teeth n^1 of shaft l. This liberates shaft l, and turning back under the influence of spring m feeder l^1 pushes the cartridges one by one underneath the opening in the bottom of the breech-case, from where they are pushed into the cartridge-chamber by the advancing breech-bolt. The shot having been fired, the cartridge-shell is extracted by the extractor in the usual manner as the breech-bolt recedes under the influence of spring g.

The mechanism may be stopped or locked by the safety-bolt o, which is a sort of swivel that may be turned into a notch in the operating lever below the frame.

The handling of the carbine is extremely simple. The magazine door is opened and the cartridges either dropped in by hand or introduced by a charging-box. The magazine door having been closed, the cartridges may be fired in succession by operating the lever. Each time when the operating ring has been pulled back far enough to block the breech-bolt the finger meets the trigger protruding through the slit in the operating ring and the shot is fired. The magazine having been discharged, single fire may be kept up by dropping single cartridges into the top opening of the breech-case. For accurate shooting the breech may be closed, putting the finger against the outside of the operating ring for pulling it back and then introducing the finger to pull the trigger for an accurately-aimed shot.

The taking apart of the carbine for cleaning, oiling, and other purposes is very easy and simple. Turn-button i^3 (Figure 1) is turned aside and plate i removed. Now pin c^1 is pulled out and the breech-bolt is free to be removed by pulling the trigger to lower the sear. The putting together is effected in the reverse manner.



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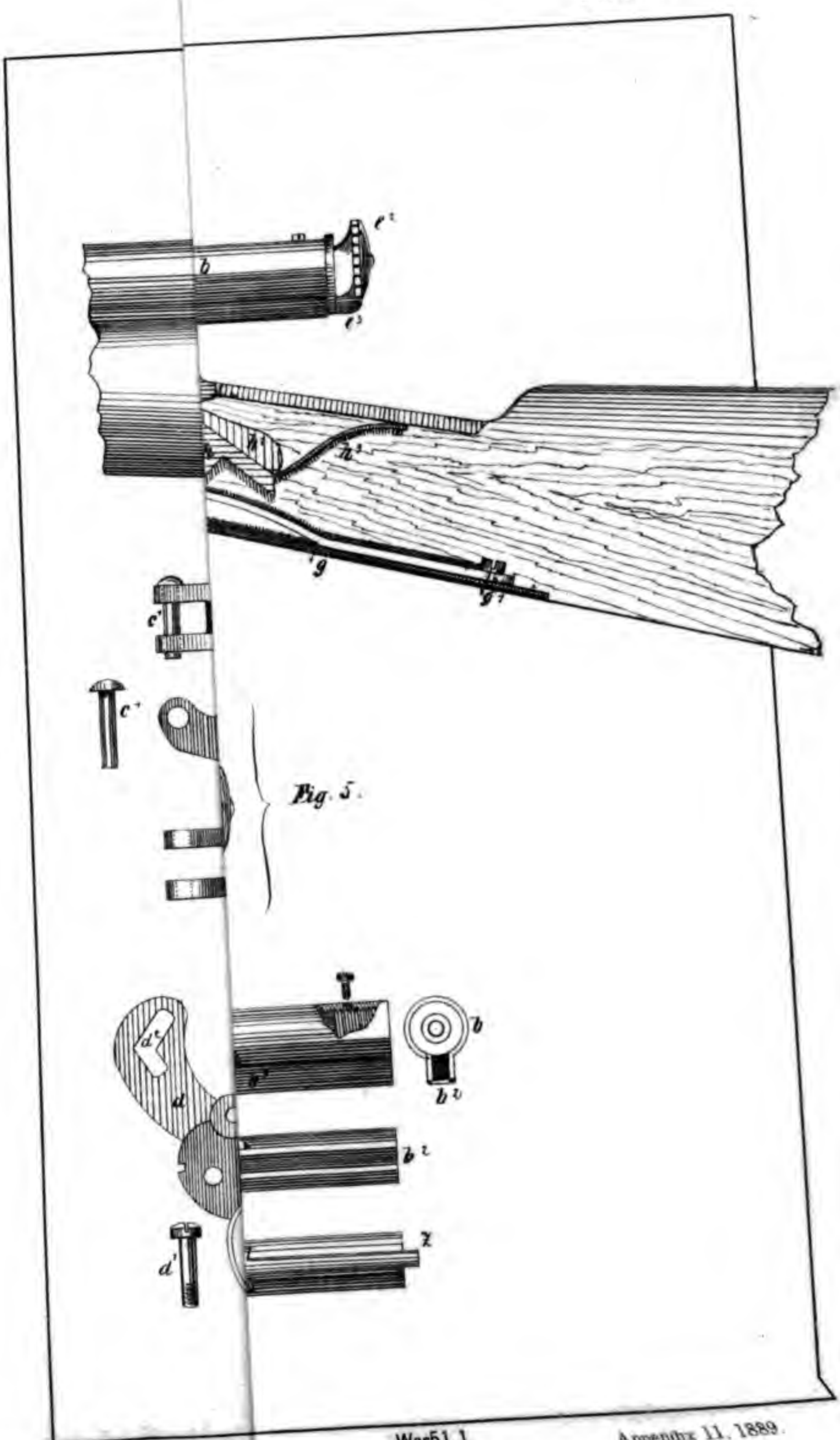

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APPENDIX 12.

TRIAL OF SMITH & WESSON .38 CALIBER, HAMMERLESS SAFETY REVOLVER, DOUBLE ACTION; AND COLT .38 CALIBER REVOLVER, DOUBLE ACTION, NEW NAVY PATTERN.

(3 plates.)

Proceedings of a Board convened by virtue of the following indorsements on letter of Capt. W. P. Hall, 5th Cavalry, to the Chief of Ordnance, U. S. Army, dated March 7, 1889, requesting that 12 hammerless S. & W. revolvers, caliber .38, 6-inch barrel, be issued to his troop with sufficient ammunition for testing them.

[First indorsement.]

ORDNANCE OFFICE,
Washington, March 14, 1889.

Respectfully referred to the commanding officer of National Armory, with instructions to procure one of the revolvers referred to within and test it, reporting the results, with his views and recommendations, to this office.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

[Second indorsement.]

NATIONAL ARMORY,
Springfield, Mass., March 16, 1889.

Respectfully referred to a Board to consist of Capt. J. C. Clifford and Lieut. J. W. Benét for test and report. The test will be that prescribed in "Regulations for the trial of army revolvers at the National Armory," printed at the Armory December, 1876.

A. R. BUFFINGTON,
Lieutenant-Colonel of Ordnance, Commanding.

NATIONAL ARMORY,
Springfield, Mass., April 15, 1889.

The Smith & Wesson safety revolver, caliber .38, with suitable ammunition having arrived at this Armory, the Board met pursuant to the foregoing indorsements, at 10 a. m. Present: both the members. Verbal orders were received from the commanding officer, National Armory, to test at the same time with the Smith & Wesson safety revolver, the new navy double action .38 caliber, revolver, submitted by the Colt's Patent Fire-arms Manufacturing Company. The Board decided to keep no daily record of its proceedings, but to conduct the trial of the two revolvers in such a manner and at such times as should be practicable.

GENERAL DESCRIPTION OF THE SMITH & WESSON SAFETY HAMMERLESS REVOLVER, CALIBER .38.

Nomenclature of component parts.

(Plate 2.)

1. Barrel.
2. Cylinder.
3. Frame.
4. Stop.
5. Barrel catch.
6. Safety lever.
7. Guard.
8. Side plate.
9. Base-pin.
10. Barrel catch lifter.
11. Cylinder hook.
12. Extractor post.
13. Extractor.
14. Trigger.
15. Hammer.
16. Stock screw.
17. Strain screw.
18. Short plate screw.
19. Joint pivot and screw.
20. Hammer stud.
21. Firing-pin bushing.
22. Firing-pin.
23. Extractor stud.
24. Right-hand stock.
25. Left-hand stock.
26. Extractor cam and latch.
27. Sight.
28. Split spring.
29. Hand spring.
30. Barrel catch spring.
31. Firing-pin spring.
32. Cylinder hook spring.
33. Cylinder stop spring.
34. Latch spring.
35. Hand.
36. Stirrup.
37. Front sear.
38. Extractor spring.
39. Main spring.
40. Nut.
41. Trigger spring.
42. Barrel catch-lifter spring.
43. Safety latch.

Also the following pins:

44. Cylinder stop spring pin.
45. Latch spring pin.
46. Safety lever pin.
47. Cylinder hook pin.
48. Barrel catch pin.
49. Firing-pin bushing pin.
50. Barrel catch lifter pin.
51. Stop-pin.
52. Latch-pin.
53. Trigger-pin.

The manufacturers in their circulars make the following claims for this revolver:

The great number of accidents recorded during past years in the use and handling of the revolver has made it evident that some decided change in this arm, by which these accidents shall be avoided, is not only desirable but necessary. To this end much time and thought has been expended, but not until quite recently has the object sought after been fully attained in the perfection of our hammerless safety revolver, which we now offer to the public.

It is well known to all familiar with the subject that a very large proportion of the accidents with revolvers arises from some unintentional manipulation of the hammer. Either it receives a blow, is allowed to slip off the thumb in cocking, is accidentally caught on some foreign object and partially raised, or is unintentionally left at full cock. The only other and a fruitful source of accident is the unintentional manipulation of the trigger.

In the new hammerless safety revolver all these liabilities to accident are made impossibilities; first, by placing the hammer of the arm entirely within the lock frame, so that no external force whatever can be applied to it: and second, by so arranging the trigger that it can not be pulled, except at the instant of deliberate firing, and only by this means. One very important feature of this arrangement is the safety of the arm in the hands of children, as no ordinary child under eight years of age can possibly discharge it. The new arm is also provided with a rebounding lock, as an additional source of safety and protection.

We think it safe to say one of these revolvers may be carried with as little danger of injury to the person carrying it as if it were a block of wood, and yet it possesses in a high degree all the essential qualities of a weapon of defense, or an arm for target practice. As a weapon of defense it has the advantage, on account of the hammerless feature, of being readily drawn from the pocket.

As to weight and general appearance, the hammerless safety revolver is but one-half ounce heavier than our double-action model of the same caliber, and fully as handsome in appearance as anything yet issued from our works. In addition to the above-described elements of safety, this revolver has the automatic ejector, as applied to all of our former models, and, in short, possesses every desirable quality of the well-known Smith & Wesson revolvers.

OPERATION OF THE PARTS.

The hammer and all the upper part of the lock mechanism is located entirely within the frame, so that the latter at its upper part may be entirely closed, with no apertures through which to admit dirt. A separate firing-pin is used to explode the cartridge, which, when the hammer is thrown forward and is pressing against the firing-pin, projects through the upper part of the frame; but when the pressure of the hammer is withdrawn, or the hammer is moved back, as when the hammer rebounds, or is partially or wholly cocked, a small spring placed between the frame and the firing-pin forces the latter back also, so that it does not then project through the frame.

The hammer, which is acted upon and raised by the trigger, as in the "double-action revolver," is kept constantly locked by the safety latch, which is held in position by the safety-latch spring. When held in the hand for firing, the natural pressure exerted by the hand in the movement of pulling the trigger upon the safety lever causes it to act upon the safety latch, raising it and releasing the hammer. In its other features the arm closely resembles the Smith & Wesson .38 "double-action revolver." The barrel catch and cylinder catch, however, differ from the ordinary double-action model. The cylinder and ejector can be removed for cleaning and replaced with great ease and rapidity, as follows:

To remove the cylinder and ejector, open the arm until the piston protrudes about half way, press the cylinder catch, and turn the cylinder two turns to the left.

To replace the cylinder and ejector, open the arm to its full capacity, press the cylinder catch, carry the cylinder forward upon the base-pin, and give it two turns to the right.

DIMENSIONS.

Total length, 9.23 inches.
Length of barrel, 5 inches.
Diameter of bore, .35 inch.
Number of grooves, 5.
Kind of grooves, circle of about .36 inch.
Depth of grooves, .005 inch.
Grooves, depth, uniform or not? Uniform.
Grooves, twist of, one turn in 18.56 inches.
Grooves, twist, right-handed.
Grooves, twist, uniform.
Number of chambers, 5.
Diameter of chambers, .388 inch.
Length of cylinder, 1.215 inches.
Diameter of cylinder, 1.30 inches.
Total weight, 1 pound 1,690 grains; 1.24142 pounds.
Weight of powder charge, 15 grains.
Weight of bullet, 146 grains.

THE NEW COLT NAVY DOUBLE-ACTION REVOLVER, 0''.38 CALIBER, WITH SIMULTANEOUS EJECTOR.

Figure 1, Plate 3, gives a side view of the revolver complete; Figure 2, a longitudinal sectional side view, showing the parts in the normal position; Figure 3 the same as Figure 2, showing the parts as after the discharge of the hammer and before the release of the trigger; Figure 4, a forward end view; Figure 5, a transverse section through the frame, showing a rear end of the cylinder and the spindle with the crane; Figure 6 a horizontal section showing a top view of the locking bolt of the cylinder, its slide and locking dog; Figure 7, a sectional side view of the same; and Figure 8, a transverse section in rear of the cylinder.

NOMENCLATURE OF COMPONENT PARTS.

1. Frame cap.
2. Cap screws (2).
3. Frame.
4. Recoil bouching.
5. Cylinder.
6. Ejector and ratchet.
7. Ejector rod.
8. Ejector rod head.
9. Ejector spring.
10. Crane.
11. Crane nut.
12. Crane lock.
13. Crane lock screw.
14. Barrel and sight.
15. Latch.
16. Latch spring.
17. Latch pin.
18. Half stocks (2).
19. Escutcheons (2).
20. Stock screws (2).
21. Stock pin.
22. Hand.
23. Hand spring.
24. Trigger.
25. Trigger-pin.
26. Trigger rebound pin.
27. Rebound spring.
28. Rebound lever.
29. Rebound spring pin.
30. Rebound lever pin.
31. Hammer.
32. Hammer strut.
33. Hammer strut spring.
34. Hammer strut spring pin.
35. Hammer pin.
36. Hammer stirrup.
37. Hammer stirrup pin.
38. Main-spring.
39. Strain screw.

DIMENSIONS.

Total length, 11.[illegible] inches.

Length of barrel, 5.[illegible] inches.

Diameter of bore, .[illegible]2 inch.

Grooves, number of, 6.

Grooves, kind of, circle of about .5[illegible] inch.

Grooves, depth of, .005 inch.

Grooves, depth, uniform or not? Uniform.

Grooves, twist, right-handed or left-handed? Left-handed.

Grooves, twist, uniform, increasing or decreasing? Uniform, one turn in 16.02 inches.

Chambers, number of, 6.

Chambers, diameter of, .382 inch.

Cylinder, length of, 1.425 inches.

Cylinder, diameter of, 1.45 inches.

Total weight, 2 pounds 112 grains.

Weight of powder charge, 1[illegible] grains.

Weight of bullet, 13[illegible] grains.

OPERATION OF THE PARTS.

The frame A has a recess formed therein to receive the cylinder B, the frame at the rear carrying the lock mechanism, and the barrel being attached to the forward end in the usual manner. The forward part of the frame is [illegible], a portion C forming what is called the "crane." This portion C is constructed with a spindle D, arranged in a corresponding seat below the cylinder, parallel with the axis of the cylinder, and so as to form a pivot upon which the cylinder may swing laterally outward and inward when it is desired to charge the cylinder or eject the shells therefrom, the ejector being of common construction. It is desirable that possible contact of the hammer with the cartridge in the cylinder shall be prevented except when the cylinder is in its proper position, and to prevent the outward movement of the cylinder, except when the hammer shall have been so far retracted as to take its nose out of the path of the cylinder. To accomplish this object, the rear end of the spindle D is constructed with a notch, *a*, which, when the cylinder is in the closed position, stands vertically and in the plane of a finger, *b*, on the hub of the trigger E (see fig. [illegible]), which is hung in the frame upon a pivot, *d*. When the parts are in the normal position, as seen in Fig. 2, the trigger is forward, and the finger *b* stands in the plane of the groove *a* of the crane-spindle, but so far to the rear of it as to be out of engagement therewith; therefore with the parts in this position the cylinder crane is free to be turned upon the axis of the crane. If, however, with the parts in this position, the trigger be pulled, as indicated in Fig. 3, the finger *b* passes into the groove *a* of the crane-spindle and interlocks therewith, so as to prevent the crane from turning. Consequently the cylinder can not be turned from its place in the frame except when the trigger is in the normal position. If the cylinder is thrown outward, as indicated in broken lines (Fig. 4), the result will be to turn the notch [illegible] out of the plane of the finger *b* on the trigger, as indicated in broken lines (Fig. [illegible]). Consequently, while the cylinder is in this outwardly-turned position the rear end of the spindle serves as a stop for the trigger, and the trigger can not be pulled. Any movement of the hammer is therefore avoided. If the cylinder is not properly returned into its place the groove *a* of the crane-spindle will not coincide with the path of the finger *b*. Consequently the trigger can not be pulled to discharge the hammer until the cylinder is in its proper position for firing. [illegible] the same spring as the trigger-spring, a two-armed lever F [illegible] in the frame below the hammer, in rear of the trigger, and the [illegible] F, extending forward, is engaged with a [illegible] upon the trigger by means of a [illegible] the lever, so that both the trigger and lever must move together [illegible] parallel.

The arm G of the lever extends rearward and rests upon a [illegible] spring H, arranged in the frame beneath the mainspring I. The hammer [illegible] upon its pivot K in the frame in the usual manner above the arm G. The [illegible] of this arm G forms a [illegible] adapted to bear upon the [illegible] of the hammer pivot. The [illegible] of the [illegible] spring H is to force the [illegible] of the lever upward, and this upward movement of the arm G produces a [illegible] downward movement of the other arm, which is [illegible] to the trigger [illegible] to force the trigger to its forward or normal position [illegible] Fig. [illegible]. The spring, however, [illegible] of the trigger, which [illegible] the [illegible] after the [illegible] of the trigger [illegible] hammer [illegible] the [illegible] When the trigger is [illegible] the [illegible] forward and the hammer [illegible] arm [illegible] the hammer [illegible] rearwards, as seen in Fig. [illegible], to such an extent as to take the nose [illegible] out of the path of the cylinder. When the trigger is pulled [illegible] the strut *m*, hinged to the hammer above the pivot, and so that a continued pull of the trigger will throw the hammer to the full cocked position, where the nose *l* will escape from the strut *m*, and allow the hammer to fly forward as seen in Figure 3; the pull of the trigger first imparting the rotation to the cylinder by means of the hand *n*, hung upon the trigger in the usual manner. Under this arrangement the rebound spring serves also as a trigger spring, and as the pull of the trigger is prevented except when the cylinder is in the proper position, it follows that the hammer can not be discharged except when the cylinder is in such proper position. The bearing between the cam-shaped portion of the rebound lever G F is in such relation to the hammer, when the hammer stands in the rebound position, as seen in Figure 2—that is, in a direct line between the axis of the pivot of the hammer and lever—and the point of the strut *m* extends down so as to nearly touch the top of the nose *l* of the trigger, so that if the hammer should be forced forward from its rebound position, the strut *m* will strike the nose of the trigger, the tendency of which will be to turn the trigger forward; but as the arm G of the rebound lever is by such accidental movements of the hammer depressed, the other arm F of the lever at the same time through the stud *g* upon the trigger, tends to turn the trigger backward against the strut *m*, and thus the hammer is positively locked. In the frame in rear of the cylinder is a central longitudinal bolt L. (See Figures 6, 7, and 8.) This bolt is in line with the axis of the cylinder; and when the cylinder is in the closed position the bolt enters a corresponding concentric recess, M, in that end of the ratchet or cylinder, and as seen in Figures 2 and 3, when so engaged, the cylinder is held in its proper position for firing, and from which it can not be removed until the bolt L is withdrawn. This bolt L is attached to or made a part of a slide, N, on the outside of the frame (see Figures 1 and 6), the said slide being provided with a thumb-piece P, by which it may be drawn backward, as indicated in broken lines, Figure 1. The forward portion R of this slide forms part of the shield in rear of the cylinder. Within the frame a spring, S, is provided, the tendency of which is to force the bolt into its forward or engaging position, as seen in Figure 7. The connection T, between the bolt and the slide, forms a bevel faced dog, U, at one side of the bolt L, and this dog U stands in the path of the teeth V of the ratchet on the end of the cylinder, and interlocks therewith, the nose of the dog being opposed to the backward rotation of the cylinder. The bevel of the nose permits the ratchet to escape when turned in the advance direction. This dog, therefore, serves as a positive stop to prevent a backward rotation of the cylinder and coacts with the advancing hand of the trigger to rigidly hold the cylinder at the instant of firing—that is to say, upon the pull of the trigger the hand turns the cylinder in the usual manner until it reaches its position for firing, and there holds it until the hammer has been discharged. In such rotation of the cylinder the dog U has escaped from one tooth and engaged the next, so that while the trigger is held in the pulled position the cylinder is positively engaged as before described.

The above descriptions are compiled from the patents, advertisements, etc., of the inventors of the revolvers.

REGULAR TESTS.

1.—*Dismounting and assembling.*

(1) Find the time required by an ordinary machinist to dismount each revolver.

(2) Find the time required for the same machinist to completely assemble the parts of each revolver.

Every part must be dismounted and assembled, no matter how small.

The dismounting and assembling was performed by Mr. R. T. Hare.

It was found necessary to send to the manufacturers for special drifts and other appliances for dismounting the Smith & Wesson revolver, and only after repeated attempts, and instruction by an expert furnished by the Smith & Wesson Company, was Mr. Hare able to mount and dismount the revolver with any degree of facility. The large number of parts, the nicety of fit, and the knack required in portions of the assembling would make it impossible, the Board thinks, for an ordinary mechanic to perform this test without injuring the revolver.

The Colt revolver was dismounted and assembled by Mr. Hare without much difficulty.

The time taken was as follows:

To dismount.

	Minutes.
Smith & Wesson:	
By expert	6
By Mr. Hare	14¼
Colt, by Mr. Hare	5

To mount.

Smith & Wesson:	
By expert	6¼
By Mr. Hare	39¼
Colt, by Mr. Hare	7¼

II.—*Initial velocities.*

(1) Take the mean of the initial velocities determined by firing ten rounds, Le Boulengé chronograph used.

(2) Break up ten cartridges and weigh the charges of powder and of lead in each, separately.

Take the means of the weights of the powder and of the lead for the charge, which gives the mean initial velocity. Do this for each kind of cartridge used.

Smith & Wesson revolver, mean of charges of powder and lead obtained by breaking up ten cartridges; weight of powder, 14.125 grains; weight of bullet, 146.30 grains; length of barrel, 5.″0.

Colt revolver, mean of charges of powder and lead obtained by breaking up ten cartridges; weight of powder, 17.85 grains; weight of bullet, 150 grains; length of barrel, 5″.96.

Velocities at 25 feet from muzzle.—Smith & Wesson revolver: 607.2, 624.6, 637.4, 645.1, 664.8, 618.1, 661.6, 645.9, 607.5, 613.5, mean 635.5 feet; mean variation, 18.29 feet.

Colt revolver: 699, 729, 709, 738, 718, 733, 700, 743, 728, 730, mean 722.7 feet; mean variation, 12.96 feet.

III.—*Penetration and recoil.*

Find the penetration and recoil by means of the pendulum recoil frames. As no suitable pendulum recoil frames were available, the Board decided to omit this test. The theoretical recoil for the revolvers computed by means of the formula $\varphi=\frac{w^2 v}{2gW}$ (page 112, Report Chief of Ordnance, 1878), is as follows: Smith & Wesson, 2.1889 foot pounds; Colt, 1.8516 foot pounds. The theoretical recoil for the Colt service .45 caliber, is 3.89 foot pounds.

IV.—*Tests for accuracy.*

(1) Fire 10 rounds from a fixed rest at a target, distant 25 yards.

(2) Fire 10 rounds from a fixed rest at a target, distant 100 yards.

(3) Find the mean absolute deviation in each case.

The revolvers were operated by Mr. R. T. Hare.

Range, 25 yards.

Revolver.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.	Radius 100 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
lth & Wesson	.78	.68	1.18	.86	2.44
t	1.37	.78	1.68	1.28	2.52

Plots of the above targets, actual size, are herewith submitted and marked A and B.

Range, 100 *yards*.

Revolver.	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.	Radius 100 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Smith & Wesson......	2.56	3.60	4.91	3.84	7.50
Colt..................	4.88	8	10.11	7.76	23.90

In these tests two bullets from the Colt revolver key-holed badly.

V.—*Penetration in pine butts.*

Fire five rounds into pine butts distant 100 yards, and take a mean of the five penetrations.

Mean of five penetrations.

	Inches.
Smith & Wesson revolver..	3¼
Colt revolver..	3¾

VI.—*Rapidity of loading, firing, and ejecting.*

(Revolvers operated by Mr. R. T. Hare.)

Find the time required to fire eighteen rounds, commencing and ending with the chambers empty.

	Min.	Sec.
Smith & Wesson revolver..	0	52¼
Colt revolver..	1	13

Twenty rounds were fired from the Smith & Wesson revolver in fifty-four seconds.

VII.—*Endurance.*

Fire two hundred and fifty rounds, allowing the revolver five minutes to cool after every fifty rounds. (Revolvers operated by Mr. R. T. Hare.)

Colt revolver.—Early in the test the rebound spring proved too weak always to turn the trigger forward after the discharge of the revolver. In a large number of cases the trigger had to be pushed forward by the fingers. Otherwise revolver worked well.

Smith & Wesson revolver.—On the one hundred and fourth round the head would not revolve the cylinder, the mechanism being clogged with fouling. The cylinder was slipped off and wiped and replaced, when the revolver worked perfectly. The same difficulty occurred on the one hundred and fortieth round. The cylinder was removed as before and the clogged parts more carefully wiped than in the preceding instance, when the revolver worked well during the remainder of the test.

VIII.—*Fouling.*

Let the revolver remain forty eight hours without cleaning; after which fire fifty rounds, allowing it five minutes to cool after the twelfth, twenty-fourth, and thirty-sixth rounds.

Smith & Wesson revolver.—Cylinder clogged as in preceding test and would not revolve.' It was slipped off as before and wiped off, as was the rear of barrel. During the remainder of the test the revolver worked well.

Colt revolver.—The rebound spring would not turn the trigger forward during the opening rounds of each series. One failure of the cylinder to revolve occurred. The revolver was opened and shut again by the operator when the cylinder revolved freely.

IX.—*Dust.*

(1) The revolver to be carefully cleaned and then shaken in fine dust after which it is brushed off with the hand and fired twelve rounds.

(2) Dust again in the same manner in order to ascertain the combined effects of dusting and fouling; then fire six rounds.

Smith & Wesson revolver.—(1) In two instances it was necessary to give an extra pull to the trigger to make the cylinder revolve.

(2) The revolver worked well.

Colt revolver.—(1) At the sixth round the revolver refused to work as a double-action revolver, and it was necessary to cock the hammer by hand.

(2) Revolver still disabled as a double-action revolver, but could be worked by cocking hammer with hand. In several instances the cylinder would not revolve without considerable assistance.

X.—*Rust.*

(1) After cleaning, remove all oil and immerse in a solution of sal-ammoniac for ten minutes and expose for forty-eight hours.

(2) Fire twelve rounds.

(3) Without cleaning, load the revolver and immerse for ten minutes as before, and again expose for forty-eight hours.

(4) Fire eighteen rounds.

(5) Dismount, examine, and clean.

Both revolvers were boiled in a solution of potash to remove oil, and left over night to dry. They were then rusted as above.

Smith & Wesson revolver.—On taking the revolver out of the solution the mainspring was found to be broken. The revolver was well rusted. Considerable rapping with a mallet was necessary to make the barrel catch and cylinder hook operate, and the safety lever would not perform its functions until after some amount of manipulation. The mainspring was replaced by another one, and twelve rounds were fired from the revolver without difficulty.

Colt revolver.—The revolver was found to be well rusted, but the mechanism operated freely and the twelve shots were fired without the use of the mallet being necessary. The cylinder had to be assisted to revolve once and the rebound spring failed to push the trigger forward three times.

The revolvers were not loaded before the next immersion on account of the danger involved, but instead of plugging the chambers with corks as before, empty cartridge shells were inserted. Both revolvers were thoroughly rusted when taken out of the solution.

Smith & Wesson revolver.—The barrel catch was tightly cemented, and opened only after long-continued efforts. The hammer would not operate, and on taking off the side plate and a half-stock the mainspring (a new one, replacing the one broken in the first part of the test) was nd to be broken. It was replaced by a new one. The firing-pin ring and pin were tightly rusted, so that the spring would not oper- to return the pin. The hand would not revolve the cylinder, and further inspection it was found that the trigger spring was broken. More than an hour and a half was consumed in trying to operate this volver. As much of the rust as possible was rubbed off with rags, and ter was used upon it freely, but all efforts proving fruitless the re- lver was laid aside as disabled.

Colt revolver.—The cylinder could not be swung outwards without l from the blows of a mallet. Cartridges could not be inserted until e chambers were cleaned from rust. Eighteen rounds were fired thout much difficulty, using the revolver as a double-action revolver. e rebound spring failed to push the trigger forward in every case, and d to be assisted by the operator's hand. In two cases (ninth and th rounds) the hand would not revolve the cylinder without assist- ce.

Both revolvers were then dismounted, examined, thoroughly cleaned, d assembled.

REMARKS.

Smith & Wesson revolver.

Captain Hall, in his letter, twice speaks of this revolver as having a nch barrel. The manufacturers state that a 5-inch barrel is the gest that has ever been supplied with this model. The multiplicity parts and their nicety of fit make it almost impossible for any one, t a skilled and instructed mechanic, to dismount and assemble the m and replace broken parts, without marring or impairing the arm. On the other hand the locating the hammer and lock mechanism en- ely within the frame, renders the arm less liable to accidental injuries d prevents the parts from clogging from dust and rust. The cylin- r is easily removed and replaced, and the parts where fouling accum- ates are easily accessible. The revolver stood all the tests very well, to the last rust test; and with the most ordinary care a revolver uld be prevented from becoming rusted to such an extent. In this st, however, the arm was totally disabled. Two mainsprings were oken in this test which would seem to imply that their temper was o high.

Great stress has always been laid upon certain defects in the Smith Wesson system which would develop especially in a military arm. revolver Board, convened in 1876, speaks of the system thus: "The iciency of any revolver of this model must depend in great measure on the accuracy with which its joints are made and broken. Certain stances must not only be made exact but must remain invariable, and is believed impossible to preserve the latter condition with the rough age of the service." The Smith & Wesson revolver tested by this ard failed in the rust test, and the report goes on to say: * * * he severe rusting test, given by the Board, resulted in showing how adily this model may become unserviceable, and this test is not re- rded as a more severe trial of the arm than would frequently be ex- rienced in the service."

Captain Hall makes the following special claims for the arm:

1) A revolver cocked with the forefinger has a great advantage over one cocked th the thumb. In cocking a revolver with the thumb its position in the hand is dered very insecure at the instant the thumb is changed from the hammer to the ck, and this insecurity is so increased in cold weather as to render a premature charge probable and greatly diminish the rapidity and accuracy of fire.

Board thinks that these points seem to be well taken, and cer- Captain Hall's reputation as an expert pistol shot should give nion great weight. This claim will apply equally well to the Colt, a double-action revolver.

he Smith & Wesson revolver under discussion has an advantage over all other rs cocked with the forefinger, in the fact that there is an indication in the ich informs the shooter when the cartridge is to be struck. This new and evice renders this revolver equal, if not superior to all others even as a target

Board concurs with Captain Hall in thinking that this indication pull is a decided advantage.

he revolver has also a safety device in the stock which prevents it from being less the handle is grasped.

Board recognizes the advantage of the safety device but thinks y its use accidents will only be partially avoided. A great number nature discharges take place when the handle of the revolver ped by the soldier.

workmanship of the revolver leaves nothing to be desired and curacy of shooting is most satisfactory. Whether it will stand igh usage of the service is another question, and in this connec- aptain Hall states he has had two of these arms for more than a fired two or three thousand rounds from them and snapped them ve thousand times, without either getting out of repair a single nd has carried them on his saddle in the field for two months of ne." The cartridges used worked well in every respect and have eat advantage of having the lubricant covered by the cartridge nstead of being placed on the exposed portion of the bullet.

Colt revolver.

revolver has the great advantage of possessing a solid frame is is combined with the feature of simultaneous ejection of car- s, though the ejection is not automatic as in the Smith & Wesson. rincipal defect developed in this arm was the weakness of the re- spring which in many cases would not turn the trigger forward the dischage of the revolver. The substitution of a stronger or the addition of a strain screw would remedy this defect. l failures of the head to revolve the cylinder were noted, and on inting the revolver a large amount of dirt and fouling was found case between the hand and hand spring.

revolver does not possess the safety device of the Smith & n and is, thereby, more liable to accidental discharges when the is not grasped in the hand. It lacks the hammerless feature of nith & Wesson, but in spite of the hammer not being located ly within the frame" it showed a decided superiority in the rust Moreover having a hammer it can be used as a single action re- when its double acting mechanism is disabled, as shown in the test," and the board thinks this a decided advantage. There are y delicate parts, and suitable provisions are made against acci- The cylinder can not be swung outwards unless the hammer is ety, and the trigger and hammer are locked unless the cylinder is proper position for firing. The hand holds the cylinder after reached its position for firing until the arm is discharged, thus as a stop bolt and preventing carrying by. In accuracy the re- showed itself inferior to the Smith & Wesson, and two of the s fired key-holed, one at 25 yards distance.

The ammunition used the Board considers to be greatly inferior to that used in the Smith & Wesson revolver. The outside lubrication used on the bullets was productive of much fouling, and there was great difficulty at times in forcing the cartridges into the chambers. The Board very much prefers a cartridge where the lubricant is covered by the case.

CONCLUSIONS.

The Board would state that the Smith & Wesson revolver has passed all the tests satisfactorily except the rust test, in which it was totally disabled. The Colt revolver has passed all the tests satisfactorily except the dust test, in which it was disabled as a double-action revolver, but could be worked satisfactorily by cocking the hammer as in a single-action revolver. Whether these arms have the necessary stopping power the Board has no means of determining. The Board is of the opinion that the issue of a limited number of each of these arms would be advantageous as affording a comparison between the double-acting system and the single-action system in use in the service. Each of the revolvers possesses advantages peculiar to itself, and a competitive test in service would be necessary to determine definitely which is the superior.

There being no further business before it, the board then at 11 a. m., May 21, adjourned *sine die*.

J. C. CLIFFORD,
Captain, Ordnance Department.
J. W. BENÉT,
First Lieutenant, Ordnance Department, Recorder.

Approved:
A. R. BUFFINGTON,
Colonel, Ordnance.

Supplementary proceedings of a Board convened by virtue of the following indorsement on letter of Capt. W. P. Hall, Fifth Cavalry, to the Chief of Ordnance, U. S. Army, dated March 7, 1889.

[Second indorsement.]

NATIONAL ARMORY,
Springfield, Mass., March 16, 1889.

Respectfully referred to a Board to consist of Capt. J. C. Clifford and Lieut. J. W. Benét, for test and report. The test will be that prescribed in "Regulations for the trial of army revolvers at the National Armory," printed at the Armory, December, 1876.

A. R. BUFFINGTON,
Lieutenant-Colonel of Ordnance, Commanding.

NATIONAL ARMORY,
Springfield, Mass., June 22, 1889.

The Board met at the call of the president at 10 a. m. Present, both the members. The double-action, .38 calibre, navy revolver, previously tested and reported upon by the Board, was resubmitted by the Colt's Patent Fire-arms Manufacturing Company, with a request that it be tested for accuracy with the new .38 caliber long Colt's central-fire cartridges manufactured by the Union Metallic Cartridge Company, Bridgeport, Conn., the lubricant being placed in cannelures covered by the cartridge shell; 150 of these cartridges were furnished with the revolver. A stronger rebound spring had been substituted for the one previously used in the revolver, as recommended by the Board; this was the only alteration made. The revolver was subjected to the usual test for accuracy, as follows:

ACCURACY.

(1) Fire ten rounds from a fixed rest at a target distant 25 yards.

(2) Fire ten rounds from a fixed rest at a target distant 100 yards.

(3) Find the mean absolute deviation in each case.

The revolvers were operated by Mr. R. T. Hare, and two targets of ten shots each were taken at each range. Plots of the above targets, actual size, are herewith submitted, marked A, B, C, and D. The targets compared as follows with those made in the previous test, when cartridges with outside lubrication were used.

Range 25 *yards.*

[18 grains powder. 150-grain bullet in both tests.]

	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.	Radius 100 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
May 2. Cartridges with outside lubrication.	1.37	.78	1.68	1.28	2.52
June 22. Cartridges with inside lubrication.					
1st target......	.80	.948	1.41	1.40	2.96
2d target	.95	.98	1.46	1.13	3.04

Range 100 *yards.*

[18 grains powder. 150-grain bullet in both tests.]

	Mean horizontal deviation.	Mean vertical deviation.	Radius circle of shots.	Radius 50 per cent. of shots.	Radius 100 per cent. of shots.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
May 2. Cartridges with outside lubrication.	4.88	8	10.11	7.76	23.90
June 22. Cartridges with inside lubrication.					
1st target	3.68	2.14	4.46	3.58	8.50
2d target	2.80	3.29	4.71	3.44	7.60

During the test the revolver worked well in every particular and no key-holing of bullets was observed. The substitution of a stronger rebound-spring did not seem to appreciably increase the trigger-pull. By an inspection of the targets made, it appears that the accuracy at 25 yards is about the same as in the previous test. The accuracy at 100 yards, however, shows a decided improvement, and this though the conditions of firing were rather unfavorable, a fresh breeze blowing during the practice.

There being no further business before it the Board then, at 4 p. m., adjourned *sine die.*

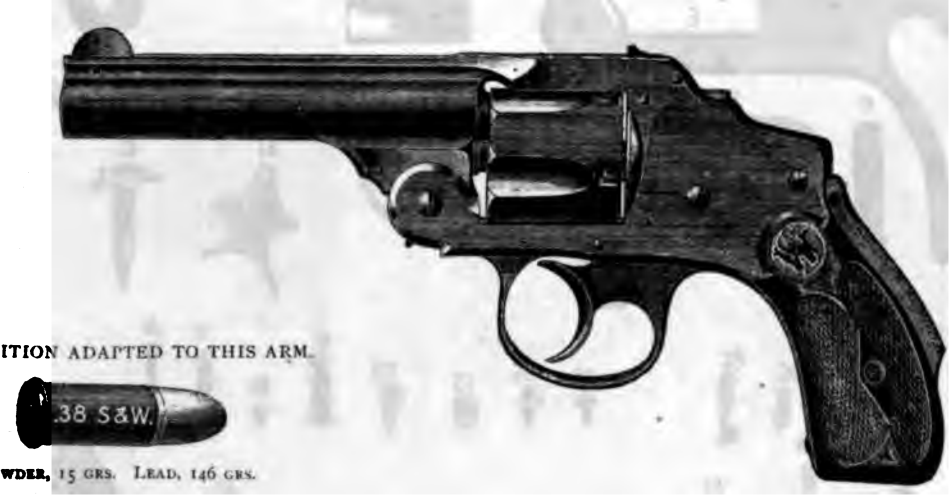
J. C. CLIFFORD,
Captain Ordnance Department.
J. W. BENÉT,
First Lieutenant Ordnance Department, Recorder.

Approved:
A. R. BUFFINGTON,
Colonel of Ordnance.

Plate 1.-

—— .38 HAMMERLESS SAFETY REVOLVER. ——

CALIBER 38-100. CENTRAL FIRE.



AMMUNITION ADAPTED TO THIS ARM.

POWDER, 15 GRS. LEAD, 146 GRS.

WITH AUTOMATIC SHELL EXTRACTOR, REBOUNDING LOCK AND PATENT SAFETY ATTACHMENT.

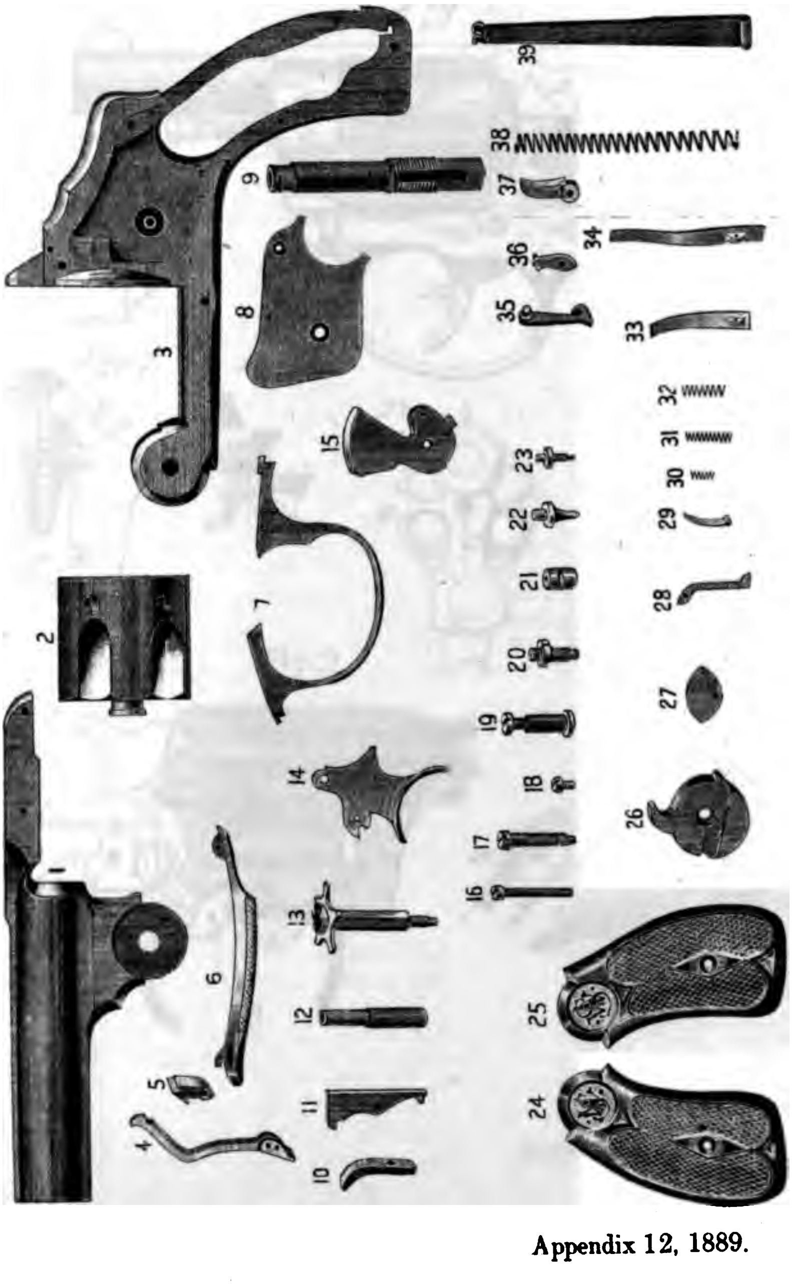
Weight 18¼ oz., Number of Shots 5, Lengths of Barrel 3¼, 4 and 5 inches.

Appendix 12, 1889.

Plate II.

COMPONENT PARTS OF THE

SMITH & WESSON
38 SAFETY HAMMERLESS REVOLVER.

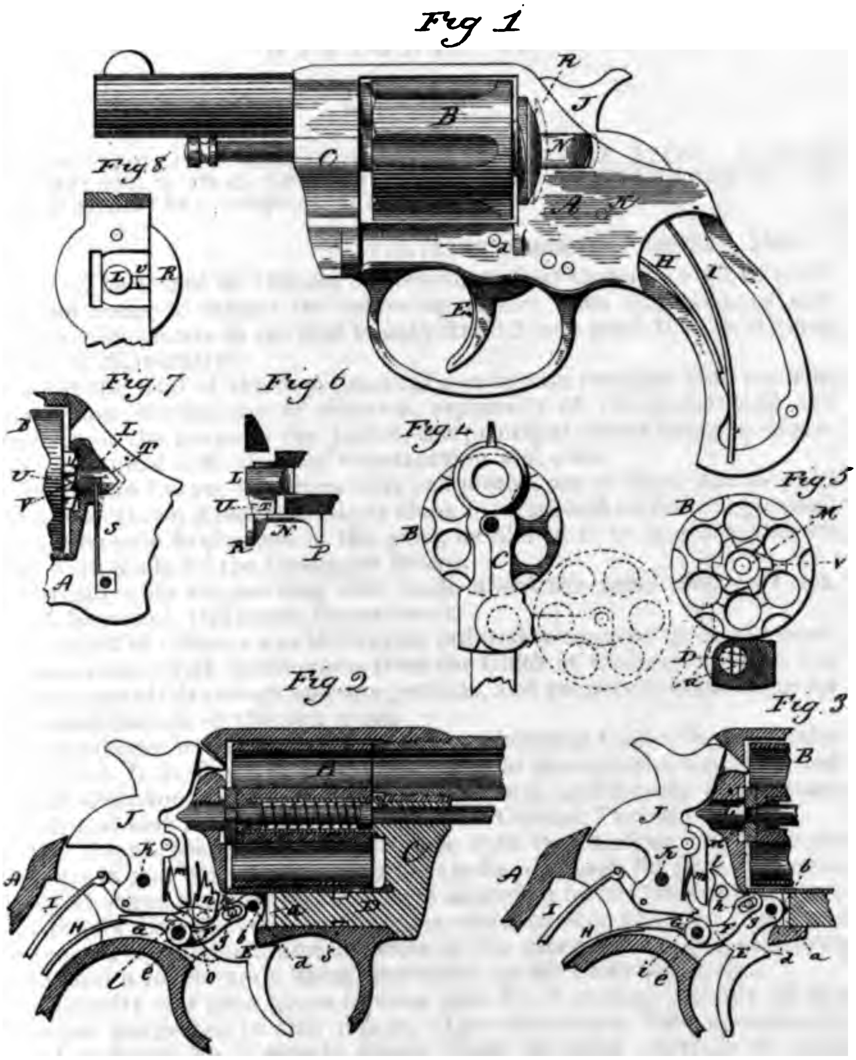


Appendix 12, 1889.

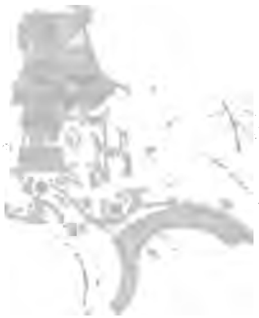
Plate III.

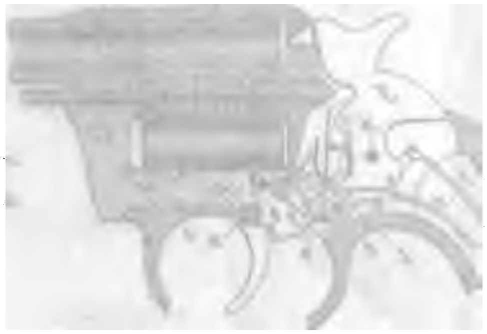
C. J. EHBETS.

REVOLVER.



Appendix 12, 1889.





APPENDIX 13.

MODIFICATIONS OF DESIGN, 3.20-INCH B. L. RIFLE, STEEL. I. GUNS NUMBERED 1 TO 25, ORIGINAL SERIES; II. GUNS NUMBERED 1 TO 25, WATERVLIET ARSENAL SERIES.

WATERVLIET ARSENAL, *April* 12, 1889.

SIR: The Board of Officers convened by Post Orders No. 33, of 1887, has the honor to submit the following report upon the changes and modifications made in the first twenty-five 3.2-inch steel B. L. field guns, Nos. 1 to 25, inclusive.

After the trial of the experimental gun certain changes were made in shape and dimensions of exterior, especially of the jacket and the position of the hinge in the jacket, the principal object being to diminish mechanical difficulties of construction and cost.

When the twenty-five guns were completed, one of them was shipped from Watertown Arsenal to Sandy Hook for trial, and certain suggestions with reference to changes in the guns, as shown to be necessary in firing. were made by the Ordnance Board.

Certain other suggestions were made about the same time by Capt. C. C. Morrison, Ordnance Department.

A Board of Officers was thereupon ordered to convene at this arsenal, in accordance with instructions from the Chief of Ordnance, which was to examine all drawings and suggestions, and prepare specifications for the manufacture of the new guns.

In obedience to this order the Board, composed of Capt. Charles Shaler and Lieut. L. L. Bruff, took up the subject of the changes recommended by the Ordnance Board, by Captain Morrison, and certain suggestions which had also been made by Lieutenant-Colonel Parker.

The Board, therefore, in accordance with instructions made certain changes in gun No. 25 which was sent to Sandy Hook for trial. Certain of the changes made on this gun were approved by the Ordnance Board, and others disapproved. In the meantime various changes had been suggested by yourself, and by some of the other officers and employés here, and a report upon them forwarded to the Ordnance Office.

Authority was then given to alter gun No. 3 so as to embody all the changes suggested in this report. The alterations were accordingly made, and gun No. 3 sent to Sandy Hook for trial. Certain of these changes were approved by the Ordnance Board, and certain others disapproved as before. The following changes are those made on guns Nos. 3 and 25, which were approved by the Ordnance Board and by the Chief of Ordnance, with certain minor ones made afterwards as they were shown to be necessary either in process of manufacture or in further firing here or at Sandy Hook.

Changes in tube.

(1) The shoulder at the front of gas-check seat has been removed. The gas-check seat is now a straight taper, whose maximum diameter is 3.53 inches, minimum diameter, 3.40 inches, and length 1.56 inches. The front shoulder was found objectionable as it was liable to collect fouling. Furthermore, the De Bange check could not be used with this shoulder. By giving the seat a straight taper both the De Bange and the Freyre checks can be used without trouble, and the free introduction of charge and projectile is assured.

(2) The rear end of tube has been rounded with a radius of .10 inch. This does away with the sharp corner at the rear end of tube which was liable to be burred up or dented by the introduction of the projectile, was apt to cut the hands in loading, and might interfere with the proper entrance of the gas-check into its seat.

(3) The shot chamber is lengthened .6-inch to allow the full charge of 3.75 pounds of powder to enter freely.

Changes in jacket.

(1) The recess for latch-pin in jacket is milled out, and consequently its shape changed from a rectangular to a circular groove. This change was made to prevent the accumulation of fouling in the recess, and also because it was much cheaper and easier to make mechanically.

(2) The seat of carrier-ring in jacket is bored cylindrical for a length of 1 inch, and taper for a length of .20-inch, from the rear outer edge of the seat; diameter of cylindrical part 6.517 inches; of taper, maximum, 6.55 inches.

The object of this change is, as follows:

The .2-inch taper forms a tight joint, centers the carrier-ring, and prevents the entrance of dust, etc., during transportation, while the cylindrical bore gives a clearance between carrier-ring and jacket, and prevents the fouling from acting to jam the carrier-ring.

(3) A slight change has been made in the form of the hole for vent bushing, necessitated by a corresponding change in the form of the exterior of bushing.

Changes in trunnion-hoop.—(1) The trunnions have been lengthened to 2.7 inches.

Changes in sleeve.—None.

Changes in key-ring.—None.

BREECH MECHANISM.

Changes in breech-block.

(1) The old guide grooves in block are filled up with steel pieces secured with screw pins; the old groove for latch-pin is also filled up in the same manner.

(2) A plate .35-inch thick has been inserted between the front face of the breech-block and the rear face of the gas-check ring, to lengthen the spindle in order to bring the gas-check ring to a proper bearing in its seat. This is necessary on account of the boring out of the seat taper In order to remove the front shoulder in the seat it was necessary to increase the diameter of the seat in rear, and this brought the gas-check ring some distance further forward. It also corresponds nearly to the position of the De Bange check in the guns and gives very nearly the same volume of powder chamber in the two cases.

These guns are all fitted with the Freyre gas check, but the De Bange can be used in them.

(3) A circular groove has been cut in the rear portion of the block, for the guide sectors to work in during the rotation of the block. This is rendered necessary by the increased width of the sectors.

(4) A transverse groove has been made for the inner end of the latch pin, and a longitudinal groove at the front of the block for the same purpose.

The inner end of the latch-pin now moves along the surface of the smooth sector of the block, except at each end of its travel where it drops into an inclined groove for unlocking the carrier-ring.

(5) A transverse and longitudinal groove has been made for the stop. Only one stop is now used instead of two as formerly.

(6) The block is counter-bored from the rear for a distance of .35-inch, which is necessitated by the introduction of the plate .35-inch thick, placed between front of block and rear of gas-check ring. As the same spindles are used as before, the spindle is .35-inch further forward.

(7) A washer .35-inch thick is put on the spindle in front of counterbore in the block to bring the spring of the gas-check into play—as before the insertion of the .35-inch plate.

(8) A stop has been put on the right lug of the block, riveted on—to limit the upward motion of the lever-handle.

(9) The lugs of lever-handle have been closed slightly to make the lever handle fit tightly in them.

(10) The holes for securing pins in lugs of lever-handle have been filled up, and the securing screw now enters the lever-handle and its pin.

(11) The edges of all threads and grooves in block have been rounded.

(12) The size of the holes for the lever-handle pin in the lugs of the block, have been changed, owing to a corresponding change in the pin. The hole in the right lug is larger than that in the left.

Changes in carrier ring.

(1) The guides in the carrier-ring have been made a solid part of the ring, instead of the old stops which were screwed and fitted to it.

(2) These guides have been made of the same width as the smooth sectors in the breech-block, so that they now fill completely the sectors, and give greater steadiness to the block from their increased bearing surface. They also render unnecessary the cutting of the old guide or stop grooves in the block. The advantages in the first change are obvious.

(3) One stop is now used instead of the two formerly. This stop enters from the side of the hinge, and is secured in place by a screw. By removing the screw the stop can be taken out and the block withdrawn entirely from the carrier-ring after removing latch-pin. Previously it was necessary to remove two stops and take out the latch pin, which latter was of itself difficult.

(4) A latch-plate has been introduced to cover the latch-pin. This plate is secured to the carrier-ring by two large screws and is easily removable, and when removed all parts of the latch-pin and spring are accessible. Formerly if any breaking or jaming of the parts of the latch occurred, it was almost impossible to reach them and remedy the defect.

(5) Grooves are made in the guides of the carrier-ring to allow free escape for the air in opening and closing the breech.

(6) The metal has been removed from the front face of the carrier-

ring to a depth of .05-inch and over two arcs, one at the top and the other at the bottom of the ring, extending from near the latch-pin to near the hinge. This has been done to prevent the fouling from interfering with the closing of the carrier-ring.

(7) A hole has been drilled through the front face of carrier ring at the latch-pin, to allow the projecting stud in base-ring to enter and lift the latch on closing the breech.

(8) The seat of the cam of lever-handle in carrier-ring has been rounded at both edges to prevent burring up of the seat by the cam in closing the lever-handle.

(9) The swing of the carrier-ring has been increased to 150°.

(10) The sharp edges of the carrier-ring have been rounded.

(11) Screws have been substituted for pins for securing the hinge-pin, and they enter the lugs of the hinge of carrier-ring at right angles to the axis of the piece, instead of parallel to the axis as formerly. These changes have been made because the screws are less liable to jar loose when inserted in this manner than when inserted parallel to the axis, and are less liable to jar out than the pins.

(12) Certain small changes of shape of the carrier-ring between the lugs of hinge have been made, necessitated by the increased swing of 150°.

Changes in lever-handle.

(1) The projection has been removed from rear of lever-handle. This was useless and added to the cost.

(2) The shape of the hole for lever-handle pin is now hexagonal, instead of round. This was necessitated by a corresponding change in shape of pin. Formerly the pin was fixed in the lugs of lever-handle by two stay-pins, and the handle rotated around the pin.

Now the pin and lever-handle rotate together, and the pin is secured to the handle by a screw, which enters the handle vertically when the latter is down. The head of this screw is upset to prevent jarring out.

(3) The lever-handle now fits tightly in lugs of block. This is to prevent possible unlocking during transportation and in firing from rotation of breech-block, as the lower end of the handle locks firmly in the jacket and the cam or upper part in the carrier-ring. If the handle were loose, any jar might cause it to fly upward, and so loosen its hold both on jacket and carrier-ring, when the block would be free to rotate.

(4) The edges of cam of lever-handle are rounded to prevent burring of seat in closing.

Changes in lever-handle pin.

(1) The pin now consists of four parts:

(*a*) The head, which bears against the stop on right lug of breech-block.

(*b*) A cylindrical portion, which bears in the right lug of block.

(*c*) A hexagonal portion, which bears in the lever-handle.

(*d*) A second cylindrical portion, smaller than the first, which bears in the left lug of lever-handle. All these are in one piece. The old shape was cylindrical throughout.

Changes in securing screw for pin of lever-handle.—(1) This has been changed to a screw entering handle and pin vertically when handle is closed. Formerly there were two pins entering lugs in block.

Changes in bronze-handle.—None.

Changes in screws for bronze-handle.—(1) The heads of screws are upset to prevent jarring out.

Changes in obturator-spindle.—None.

Changes in gas-check rings.—(1) The ring has been turned down on the exterior to a slightly smaller diameter, on account of the straight taper of seat and lengthening of breech-block .35 inch.

(2) Two grooves have been turned on the exterior of ring to act as an air packing and to collect oil and dirt, if any, on gas-check seat. The grooves are .01-inch deep.

Changes in nut of obturator-spindle.—(1) One nut has been substituted for two, the single nut being of the same length as the sum of the other two. This was done because the second or locking nut was useless as a locking nut, and hence there was no reason for having the two.

(2) A spline screw has been inserted in the nut and obturator stem, being halved into each. The position of this screw is fixed after firing a few rounds and ascertaining the proper amount of initial play of the gas-check ring. The screw is intended to maintain this initial play, and to prevent any relative movement of the nut and spindle in revolving the breech-block.

Changes in spring of obturator.—None.

Changes in vent bushing.—(1) The first vent was axial. This was changed to a radial vent, entering the powder chamber at the maximum diameter. The lower extremity of the vent bushing was conical, and the cone projected into the powder chamber. The upper extremity of the vent projected from the surface of the gun and was square in cross-section, so that it could be readily unscrewed.

The present vent is flush with the powder chamber, has no conical extremity, but is cylindrical and threaded all the way. The upper extremity is square in section, and projects above the exterior surface of the gun.

Changes in base-ring.—(1) A portion of the rear thread of base-ring on the right side is scraped off to allow the De Bange check to clear the thread, in opening, when this check is used. This was done in guns Nos. 3 and 25, but not in the others, as they are all fitted with the Freyre check, and with this check it is not necessary.

(2) A hardened steel stud has been inserted in the rear face of the base-ring on the right side. This enters the hole in the front face of carrier-ring and lifts the latch-pin to its traveling position.

Changes in latch-pin.—(1) The old latch-pin has been entirely abandoned. The new latch-pin is made of best Norway iron, case hardened.

(2) It is made in one piece instead of several.

(3) The upper part of the latch is rectangular in cross-section, and the lower, which bears on the breech-block, is round.

(4) A rectangular projection from the lower part of the pin forms a seat for the retracting spring, which bears at its upper end on a corresponding projection in the latch-plate.

(5) An oblong hole in the front face of the pin, with inclined surfaces at its upper and lower ends, forms a bearing for the hardened steel stud on the rear face of base-ring, and by its action the latch is lifted from its recess in the forward end of the block on closing the carrier-ring.

(6) The center line of the latch-pin is radial. This gives it a better bearing on the block.

Changes in latch-pin spring.—(1) This spring is now made oval instead of cylindrical, and does not surround any part of the latch-pin.

No drawings of these changes are submitted with this report, as all these changes are embodied in the new guns and will be fully detailed in the report upon them.

CHARLES SHALER,
Captain of Ordnance.
LAWRENCE L. BRUFF,
Lieutenant of Ordnance.

The COMMANDING OFFICER,
Watervliet Arsenal.

WATERVLIET ARSENAL,
West Troy, N. Y., July 17, 1889.

SIR: The Board of Officers convened by Post Order No. 33, of 1887, has the honor to submit the following report upon the changes and modifications which have been made in the twenty-five new 3.2-inch steel breech-loading field guns, manufactured at this arsenal, and numbered from 1 to 25, Watervliet series.

A previous report by this Board has been submitted, giving the changes in the first twenty-five guns. These first guns are numbered from 1 to 25 also, but those numbered from 1 to 5 were made at the Watertown Arsenal, and are so marked, while those numbered from 6 to 25 were made at the West Point Foundry and are stamped "W. P. F."

Many of the changes and modifications noted here were also made on the first twenty-five guns, and were reported previously. It has been thought best for the sake of clearness to enumerate them all here, instead of referring to the previous report.

For the Board.

CHARLES SHALER,
Captain of Ordnance, President.

The COMMANDING OFFICER,
Watervliet Arsenal.

CHANGES IN FORGINGS.

Tube.

(1) The length has been increased from 85.5 inches net to 86.2 inches, with the addition of 4 inches for specimens, making the total length 90.2 inches.

The object of this is to give more stock for boring and rifling as the muzzle end is apt to be imperfect after these operations.

(2) The diameter of the rough bore has been changed from 2.75 inches to 2.60 inches. This has been done because it is found that the tube sometimes warps on tempering in such a manner as to render it difficult to finish bore it to dimensions.

Jacket.

(1) The length has been made 27.5 inches net instead of 28.8 inches, with 2 inches additional for specimens. This decrease is because the length, 27.5 inches, is ample for finishing.

(2) The bore has been made 5.375 inches instead of 5.25 inches.

Trunnion-hoop.

(1) The exterior cylindrical part is 9 inches instead of 9.4 inches in diameter.
(2) The rim bases are 6 inches square instead of 5.1 inches.

Sleeve.

(1) The length is 13.60 inches instead of 13.70 inches.
(2) The interior diameter is 5.25 inches instead of 5.125 inches.
(3) The exterior diameter is 6.95 inches instead of 6.93 inches.

Key-ring.

(1) The interior diameter is 5.25 inches, instead of 4.875 inches.
(2) The exterior diameter is 6.875 inches, instead of 6.75 inches.

Base-ring.—No change.

Rear-sight socket.—A new forging has been added for rear-sight socket.

Breech-block.

(1) The length has been increased from 6.75 inches net to 7.10 inches, and allowing 2 inches for specimens, the total length is 9.10 inches instead of 8.75 inches. This additional length is on account of change of shape of gas-check seat, which moves the gas-check forward.

(2) The width of right side of lug has been increased from 1.70 inches to 1.90 inches, making the total width of lug 2.80 inches instead of 2.60 inches. This is to provide metal for stop.

(3) The central hole .50 inch in diameter is omitted. This is done because the holes were often bored crooked, and sometimes gave great trouble in finish boring. If the hole can be omitted without injury to the quality of the steel, it should be done.

Carrier-ring.

(1) The bore has been decreased from 4.25 inches to 3.70 inches. This to allow solid guides.

Obturator-spindle.

(1) The length has been decreased from 9.15 inches net to 8.60 inches net, allowing 4.85 inches for test specimens; the total length is 13.45 inches instead of 14 inches.

(2) Thickness of head has been increased from .9 inch to 1.60 inches. This thickness will answer for either the Freyre or the De Bange check.

(3) The shape of the spindle in rear of the head has been changed. It is now a conical frustum, with bases of 2.50 and 1.75 inches, and a length of 0.35 inch instead of a cylinder whose diameter was 1.75 inches and length 1.60 inches.

(4) The remaining length of the spindle is 1.75 inches in diameter for a length of 3.50 inches, and 1.25 inches in diameter for a length of 3.50 inches, instead of being cylindrical, and 1.125 inches in diameter for a length of 6.65 inches.

Gas-check cups (De Bange system).—Two forgings for front and rear cups have been added.

Gas check ring (*Freyre system*).—No change.

Obturator-spring (*De Bange system*).—A forging for this spring has been added.

Obturator-spring (*Freyre system*).—A forging for this spring has been added.

Obturator-nut.—No change.

Lever-handle.—No change.

Hinge-pin.—A forging for hinge-pin has been added.

Latch-cover.—A forging for latch-cover has been added. The forging is a ring, and one forging will make six latch-covers.

Lever-handle pin.—A forging for lever-handle pin has been added. One forging makes two pins.

CHANGES IN THE GUN.

Tube.

(1) The rear end of tube has been rounded with a radius of .10 inch. This does away with the sharp corner at rear end of tube, which was liable to be burred up or dented by the introduction of the projectile, was apt to cut the hands in loading, and might interfere with the proper entrance of the gas-check into its seat.

(2) The shoulder at the front of gas-check seat has been removed, leaving the gas-check seat a straight taper. This was done principally in order that either the Freyre or the De Bange checks could be used.

(3) The shot chamber has been lengthened .60 inch, to allow the full charge of 3.75 pounds of powder to enter freely.

(4) The radii of the fillets at the shoulder of the tube (exterior) have been slightly modified so as to give a clearance, with corresponding fillets on shoulder of jacket.

(5) The screw thread for key-ring has been abandoned, and a recess for a locking-ring is now cut in the tube at the front end of the sleeve, and the remaining surface of contact of tube and key-ring is an inverted cone.

(6) Owing to this change from threads to an inverted cone, the tube was left thicker at the front of key-ring, and to prevent cutting into it at this point, this thickness was retained and the tube made to taper from the front of key-ring to its original diameter at the neck. This tends to stiffen the chase, and has added slightly to the weight of the gun.

Jacket.

(1) The position of the locking-lip has been changed so as to bring it in the middle of the thickness of jacket at the forward end.

(2) The depth of the locking-shoulder has been decreased from .02 inch to .01, on account of difficulties in shrinkage.

(3) The recess for the latch in jacket is milled out, and consequently its shape changed from rectangular to a circular groove. This change was made for mechanical reasons, and to prevent the accumulation of fouling.

(4) The seat of carrier-ring in jacket is bored cylindrical for a length of 1 inch, and taper for a length of .20 inch, the taper being in rear.

The objects of this change are as follows: The .20 taper forms a tight joint with carrier-ring, centers it, and prevents the entrance of dust, etc., during transportation; the cylindrical bore gives a clearance between carrier-ring and jacket, and prevents the fouling from jamming the carrier-ring.

(5) A slight change has been made in the shape of the inner surface of lug for carrier-ring.

(6) A slight change has been made in the threading of vent-seat, on account of corresponding change in vent-bushing.

Trunnion-hoop.

(1) The position and depth of locking-lip has been changed to correspond with similar changes of locking-lip on jacket.

(2) The length of the trunnions is increased to 2.70 inches.

(3) The trunnions are joined to rim-bases with a fillet of .03 inch radius.

(4) The surface of trunnion hoop around rim-bases has been changed, so that all the work of finishing can now be done by machinery, and not by hand.

(5) The height of top of sight mass above center of trunnions is 2.72 inches.

Sleeve.—No change.

Key-ring.

(1) The screw thread has been abandoned in the key-ring, and its interior bored conical, the smaller diameter of the cone being to the rear.

(2) A small recess for the locking-ring is also bored at the rear end next to the sleeve.

(3) The securing-pin has been abandoned.

(4) The diameter of the exterior of key-ring has been changed. It now tapers with the sleeve, the exterior surfaces of the two forming an unbroken line, instead of the break at the key-ring in the former model. This has caused a slight thickening of the key ring.

(5) The radius of the curve at the forward end of the key-ring has been changed.

Base-ring.

(1) Clearances are left between threads of block and corresponding sectors of base-ring.

(2) The bottom of slotted sectors in base-ring is .01 inch below tops of corresponding threads of breech-block.

(3) A part of one of the rear threads is scraped off to allow De Bange check to swing clear of base-ring. For the Freyre check this is not necessary.

(4) A hardened steel stud has been inserted in the rear face of base ring on the right side. This enters a hole in the front face of carrier-ring and lifts the latch to its traveling position.

Locking-ring.

(1) This ring has been introduced to assist in preventing any forward motion of the exterior parts or any rear motion of the tube. It is a split ring inserted in a recess in the tube in front of the sleeve, and is covered by the key ring.

Vent-bushing.

(1) The dimensions of the exterior, especially the square, have been changed.

(2) The thread extends to the inner end of the bushing, the outer taper at the inner end being omitted.

(3) The shape of the interior termination of the vent has been changed.

(4) The inner end of vent-bushing is flush with interior wall of powder chamber.

Retracting-stud.

(1) This has been introduced into rear face of base-ring on the right-hand side for the purpose previously stated.

Rear sight-socket.

(1) This is made flush with rear face of jacket, instead of below, as formerly.

BREECH MECHANISM.

Breech-block.

(1) The breech-block has been lengthened .35 inch. This is on account of change of shape of gas-check seat, which throws gas-check further forward.

(2) A circular groove has been cut in the rear portion of the block, for the guide sectors to work in, during the rotation of the block. This is necessary because of the increased width of the guide sectors.

(3) The transverse and longitudinal grooves for the latch-pin have been changed in depth, and the longitudinal groove in shape. The stem of the latch now travels along the service of the plain sector for the greater part of its motion, and these grooves are cut at each end of its travel, so that by dropping into them it may unlock the carrier ring before firing and before opening the breech.

The shape of the forward part of the longitudinal groove has been changed, a locking recess having been added, into which the stem of the latch drops and holds the block positively from being pushed forward.

(4) One stop groove is now used, instead of two formerly.

(5) The guide sectors of carrier ring now fill the slotted sectors of breech-block, and no longitudinal grooves are necessary for them to work in, as formerly. A greater bearing surface and greater steadiness of breech-block is thereby obtained.

(6) The obturator spindle recess has been counterbored from the rear to a depth of 1.55 inches, instead of .95 inch as formerly. This is principally on account of the use of the De Bange gas-check in place of the Freyre.

(7) A stop has been placed on the exterior surface of right lug of block. The head of the pin of the lever-handle strikes against this when the handle is raised the proper distance, and thus limits its motion.

(8) The holes for securing pins in lugs of breech-block have been dispensed with. A securing screw is substituted for the two pins, and this screw enters the lever-handle.

(9) The size of holes for lever-handle pin, in lugs of breech-block,

have been changed, owing to changes in the shape of lever-handle pin. The hole in right lug is larger than that in the left.

(10) The edges of all threads and grooves have been rounded.

(11) Various changes have been made in the obturator-spindle recess, caused by changes in the obturator spindle.

(12) The play of threads of breech-block in base-ring is .01 inch.

(13) A fillet of .05-inch radius joins the lugs with the cylindrical part of block.

(14) A play of .005 inch is given between the stem of obturator and its recess.

Carrier-ring.

(1) The guides of carrier-ring have been made solid parts of the ring instead of being secured with screws as before.

(2) These guides are of the same width as the slotted-sectors of the breech-block, so that they now fill the sectors completely, and give greater steadiness to the block. They also render the old grooves unnecessary.

(3) One stop is now used instead of the two formerly. This stop enters from the side of the hinge, and is secured in place by a set-screw.

(4) A latch-cover has been introduced for covering the latch. This cover is secured to the carrier-ring by two screws, and is easily removed, allowing free access to all parts of the latch and latch-spring.

(5) Holes are made in the guides of carrier-ring to allow free escapes of air in opening and closing the breech.

(6) The metal has been removed from the front face of carrier-ring to a depth of .05-inch, and over two arcs, one at the top and the other at the bottom of the ring, extending from near the latch to the hinge. This has been done to prevent the fouling from interfering with the closing of the carrier-ring.

(7) A hole has been drilled through the front face of carrier-ring at the latch, to allow the entrance of the retracting-stud.

(8) The seat of the cam of lever-handle in the carrier-ring has been rounded at both edges, to prevent burring up the seat by the action of the cam in closing.

(9) The swing of the carrier-ring has been increased to 150 degrees.

(10) The sharp edges of the carrier-ring have been rounded.

(11) Screws have been substituted for pins for securing the hinge-pin, and they enter the lugs of carrier-ring at right angles to the axis of the piece, instead of parallel to the axis.

(12) Certain small changes of shape of the carrier-ring between the lugs have been made on account of the increased swing of 150 degrees.

(13) The shape of the bearing-surfaces of the guides has been changed, giving a clearance front and rear, so that the block may be started easily.

Obturator (*De Bange*).—Many changes have been made in the details of this check since its first trial in the guns, but they are generally in the small details, the general features being the same as in all De Bange checks.

Obturator (*Freyre*).

(1) The front face of head is a plane surface projecting .10 inch beyond the front of gas-check ring.

(2) The front edge of head is rounded with a radius of .08 inch.

(3) The remaining .02 inch of the projecting head has the same taper as the exterior surface of the gas-check ring.

(4) The locking nut has been omitted from the spindle, and its place supplied by a single nut equal in length to that of the two nuts formerly used. A spline screw is used instead of a lock-nut. The screw is adjusted by firing.

(5) The spindle has been lengthened .527 inch.

(6) The shape of the exterior of the gas-check ring has been changed, being cylindrical for a distance of .25 inch from rear face, and tapering from this point forward a distance of .40 inch.

(7) Two (2) grooves are turned on the exterior of gas-check ring, their depth being .01 inch.

Lever-handle.

(1) The projection has been removed from the rear of head of lever-handle.

(2) The shape of the hole for lever-handle pin is hexagonal instead of round as formerly.

(3) The securing screw enters head of lever-handle vertically instead of horizontally, and its head is upset to prevent jarring out.

(4) The head of lever-handle fits tightly in lugs of block.

(5) The edges of cam of lever-handle are rounded to prevent burring.

(6) The shape of pin of lever-handle is changed. The middle part which enters the handle is hexagonal, the two journals are round, the one bearing in the left lug of breech-block being smaller in diameter than the one bearing in the right lug.

The head of the pin is so shaped as to have a projection which strikes against a corresponding projection on the right lug of breech-block and stops the motion of the lever-handle.

Latch.

(1) This is made of best Norway iron case-hardened and in one piece instead of steel and in three pieces as before. The center line of the latch is radial.

Latch-spring.

(1) This is oval in shape and is larger and stronger than in the old model.

Bronze handle.

(1) The heads of the screws are upset to prevent jarring out.

Respectfully submitted.

CHARLES SHALER,
Captain of Ordnance.
LAWRENCE L. BRUFF,
Lieutenant of Ordnance, Recorder.

The COMMANDING OFFICER,
Watervliet Arsenal.

APPENDIX 14.

SPECIFICATIONS FOR THE FABRICATION, DESCRIPTION, AND NOMENCLATURE OF 3.20-INCH B. L. RIFLE, STEEL.

(5 Plates.)

WATERVLIET ARSENAL, *August* 16, 1889.

Report of Board of Officers convened by Post Order No. 33, of 1887, containing—

(1) Specifications for finishing and assembling 3.20-inch breech-loading rifle, steel.

(2) Description of 3.20-inch breech-loading rifle, steel. Accompanied by tracings, plates I, II, III, IV, and V.

(3) Nomenclature of 3.20-inch breech-loading rifle, steel.

I.

SPECIFICATIONS FOR FINISHING AND ASSEMBLING 3.2-INCH STEEL BREECH-LOADING FIELD-GUN.

GENERAL DIRECTIONS.

(1) All forgings must be carefully inspected on receipt by the inspector—

(*a*) For dimensions.
(*b*) For bending or warping.
(*c*) For eccentricity of bores.
(*d*) For defects, flaws, cracks, etc.

(2) Any imperfections that may be discovered in boring or turning must be reported at once to the inspector and work stopped pending his decision.

(3) Drawings of the guns completed and detailed drawings of all the parts will be furnished and must be adhered to. The figured dimensions given on the drawings will be used, and not the scale measurements, and the method of construction given in these specifications and shown in the drawings will be followed, and will not be changed without written instructions.

(4) The work, in all stages of progress, shall be examined and approved by the inspector or his assistants, and no parts will be assembled till measured and approved as to dimensions and workmanship. The gun will also be finally inspected when finished.

(5) The prescribed amount of shrinkage will be furnished by the Ordnance Department. In finishing shrinkage surfaces a variation of .002 of an inch from prescribed dimensions will be allowed, but the difference of diameters of superposed pieces must not vary at any point more than .0015 of an inch from the prescribed difference.

(6) A variation of .002 of an inch above prescribed dimensions and of .001 of an inch below prescribed dimensions will be allowed in the bore, and of ±.003 of an inch in the powder chamber. A variation of .01 of an inch from the prescribed exterior diameters of the gun will be allowed, of .01 of an inch in the length of the different parts, of .05 of an inch in the total length of the gun, and of ±.003 inch in depth of grooves.

(7) Shrinkage dimensions will be obtained in the following manner: The jacket, trunnion-hoop, and sleeve, or, generally the enveloping parts, will be bored to the diameters given in the drawings. To these diameters will be added the prescribed shrinkages, and the tube or enveloped parts will be turned to the corresponding diameters.

(8) All finished work must be accurate and fine finished. All bores true, straight, and concentric with exterior surfaces; free from tool marks and well polished. All ends true and at right angles to axis of bores. All screw-threads to be uniform, accurate, and smooth. The breech mechanism must fit accurately, work smoothly, and be interchangeable.

(9) The material furnished by the United States is as follows:

For each gun:
  1 tube.
  1 trunnion-hoop.
  1 key-ring.
  1 carrier-ring.
  1 cam-lever (lever-handle).
  1 gas-check ring (Freyre system).
  1 jacket.
  1 sleeve.
  1 base-ring.
  1 breech-block.
  1 mushroom head and spindle.
  1 mushroom head and spindle-nut.
  1 rear sight socket.
  2 gas-check cups (De Bange system).
  1 carrier-ring hinge-pin.
For two guns:
  1 cam-lever pin.
For six guns:
  1 ring for carrier-ring latch-cover.

All the additional parts of material required for the completion of the work must be furnished by the contractor. The screws and parts of steel must be of gun steel unless otherwise specified.

(10) [If any part of the material furnished by the United States is spoiled by bad workmanship on the part of the contractor he will be required to make good its cost to the United States; and if any work of the contractor shall be rendered useless by reason of bad material furnished him by the United States the same shall be paid for by the United States.]

(11) [The guns when completed shall be properly boxed in strong boxes, capable of transportation, and shall be delivered, ready for shipment on boat or cars, without expense to the United States. The sights for the guns shall be boxed, each in a separate box, and this box inclosed in the box containing the gun. The sights and their boxes will generally be furnished by the United States.]

(12) [The weighing of the gun, and the stamping of such letters and figures on it, as may be required by the Ordnance Department, together with such lines as may be deemed necessary to locate the position of the sights, shall be done by the contractors without expense to the United States.]

NOTE.—Brackets refer only to contract work.

SPECIAL DIRECTIONS.

PARTS OF THE GUN.

I.—*The tube.*

(1) The tube is carefully examined to detect bending or warping, or eccentricity of bore, and is centered accordingly.

(2) It is turned down to within .10 of an inch of its maximum finished diameter, bearings turned at front and rear ends, and breech end faced off.

(The object of turning down the exterior of tube before boring is to prevent springing which is found to occur if the tube is first bored and then turned.)

(3) It is then bored as follows: with roughing tool to 3.03 inches; with reamer to 3.10 inches. The boring commences at the breech end.

(4) The powder chamber is rough bored to within .10 of an inch of finished diameter.

(5) The shrinkage surfaces for jacket, trunnion-hoop, and sleeve are then turned. Before this can be done the jacket, trunnion-hoop, and sleeve must be finished, bored, and measured, and from these measurements the shrinkage diameters of the tube are determined.

(6) In laying off lengths on the exterior of the tube, and especially in locating the shoulder for the jacket, the tube is left about .05 of an inch long. This is for facing up the rear end of tube after shrinkage.

(7) Before shrinking on the jacket a length is laid off on the tube, measuring from the shoulder. This is generally about 3.85 inches, but any other length may be used. A mark is made on the tube at the corresponding point. This mark serves to determine:

First, Whether the jacket is home on the shoulder after shrinkage.

Second, The length of shoulder on jacket, which must be turned after shrinkage.

II.—*The jacket.*

(1) The jacket is first centered, bearings turned front and rear, and faced off at the breech end.

(2) It is bored from the breech end as follows: With first roughing tool, to 5.55 inches. With second roughing tool, to 5.90 inches. (This second bore extends from the breech end to the shoulder leaving sufficient metal at the latter point for finishing.) With first reamer, to 6.00 inches. (This bore extends to shoulder leaving sufficient metal to finish.) With second reamer, to 5.60 inches. (This latter size is made by centering the second reamer in the 6-inch bore by a follower ring. The shoulder is formed by using a cutter of proper shape with the 6-inch reamer.)

(3) The exterior is rough turned to within .10 of an inch of finished size. The locking shoulder is turned straight with an exterior diameter of 7.10 inches and a length from inside shoulder of jacket to front end of locking shoulder of 3.70 inches.

The rear part of exterior of jacket is to be left with a shoulder or projection of metal about .10-inch high to facilitate handling in shrinkage operations. In laying off the interior shoulder of jacket a surplus length of metal should be left at the rear end for finishing.

III.—*The trunnion-hoop.*

(1) The exterior of the hoop at the ends is rough turned to 8.50 inches.

(2) The metal between is then slotted or shaped off to the diameter 8.50 inches, leaving the metal at the rim-bases and sight mass untouched.

(The object of removing this metal before boring is to prevent change of shape in the finished bore, which is observed to occur if the hoop is bored first and then slotted and turned.)

(3) The hoop is centered and bored to 5.60 inches; the shoulder bored and the end of hoop at shoulder faced off to proper length, measuring from center of trunnions.

(4) The trunnions are turned and faced and rim-bases faced.

(5) The front of hoop is faced off and the hoop turned to finished size at the ends as far as possible.

(6) The exterior is then finished by shaping.

IV.—*The sleeve.*

(1) The sleeve is finished bored to 5.60 inches.

(2) It is rough turned to within .10 inch of finished size and faced at the rear end.

V.—*The key-ring.*

(1) This may be rough bored to .01 inch of finished size before shrinkage, but it can be left till after shrinkage when the taper is turned on the tube and the key-ring can be bored to correspond, giving the proper shrinkage.

VI.—*The base-ring.*

(1) It is faced and a bearing turned at one end.

(2) It is bored to size and threaded inside. To insure uniformity in bore a steel plug is furnished the inspector and all bores must be made to fit this plug.

(3) The thread is finished with a sizing tap.

(4) The base-ring is turned to size and the exterior thread cut. For turning and for cutting this thread the base-ring is mounted on an arbor threaded to fit interior threads accurately.

(To obtain uniformity a ring gauge is furnished of the proper interior diameter and a ring with the exterior threads cut in it. All base-rings must be fitted to these gauges. The base-ring is left about .01 of an inch long at the rear end for fitting.)

(5) A center line is laid off on the base-ring and the sectors marked out for slotting. This marking out is done by templet. The sectors are then slotted.

(6) The interior and exterior threads of base-ring may be started at any point, and may be independent of each other. But in laying off the center line it must be done so that the interior thread will occupy its proper position when screwed into rear end of jacket. This is done by supposing the center line to represent a vertical plane through the axis of the gun perpendicular to the axis of the trunnions. The distances along this line of points of the thread from rear end of tube are given in the drawing, and the center line must be located accordingly.

VII.—*The locking-ring.*

(1) This is made of good Bessemer steel, welded to shape approximately, bored to size and faced, turned approximately, and is then split along a diameter.

The parts are now ready for assembling.

THE BREECH MECHANISM.

I.—*The breech-block.*

(1) A bearing is turned at the front end, the front of lug is faced off, and the small hole through block is bored and reamed.

(2) The front end of block is faced off to proper length, measuring from front of lug.

(3) The large hole in front of block is counterbored .02 of an inch deeper than dimensions given. This is to allow for final truing up on arbor.

(4) The block is mounted on an arbor and the outside diameter turned for threading. This turning extends to the face of the lug, leaving enough metal for the radius. The face of the lug and front end of block are then faced to proper length, removing the .02 of an inch.

(5) The cylindrical recess at the rear end of block is rough turned to the same diameter as the bottom of the thread.

(6) The vertical center line is laid off on the face of the block. This must be so located that there will be sufficient metal to finish lugs of lever-handle and stop. The vertical center line coincides with the finished inner face of the left lug.

(7) This center line is transferred along the block. The distance of one thread from the front of the block, measured along this center line, is given in the drawing, and thus the thread on the block is located.

The thread is then cut. A ring gauge having the corresponding thread cut in it is provided, and all blocks must be fitted to this ring.

(8) The cylindrical recess is then finished and the exterior of the block at the front end.

(9) The exterior circumference of the block at the rear end and around the exterior of the lugs is shaped, and also between the lugs. The metal for the stop on the exterior of the right lug must be left till the hole for the lever-handle pin is drilled.

(10) The sectors are then slotted. These sectors are laid off as accurately as possible and are finally finished by filing-templets being used for this purpose.

(11) The arbor is removed and the rear face of the block finish shaped as far as possible.

(12) The holes for the lever-handle pin are then laid out; the small hole is drilled and reamed and the large one counterbored and reamed, and the stop in the exterior of the right lug planed. The block is then mounted on an arbor passing through the holes for the lever-handle pin and the outside of the lugs shaped.

(13) The grooves for the latch-pin and for the stop are then laid out by templets and planed and hand turned.

(14) The holes for the bronze-handle screws are laid out, drilled, and tapped, and the outer radius at front and rear edges of block milled.

(15) The curved surface between lugs of block is finished.

(16) The block is counterbored from the rear end and radii turned at front and rear of counterbores.

(17) The block is then fitted to the carrier-ring and gun, if necessary, by filing.

II.—*The carrier-ring.*

(1) Rough plane to within .01 inch of finished thickness on rear face and finish plane on front face,

(2) Slot of metal on exterior of ring and between lugs parallel to axis, leaving about .05 inch for finishing.

(3) Lay out the center lines, the bore, the recess for latch-pin cover, and holes for hinge-pin, these holes being .05 inch smaller than finished size; shape out recess for latch-pin cover and fit cover in recess; drill and tap holes for securing screws in cover and ring, and secure cover in place with temporary screws, whose heads are below the finished surface of cover; drill holes for hinge-pin .05 inch smaller than finished size.

(4) Finish bore carrier-ring and counterbore recess in ring with latch cover in place, measuring from front face of carrier-ring.

(5) Mill interior and exterior faces of lugs, and also outer circumference, giving the proper taper.

(6) Mill out surface joining exterior surface of lugs and taper surface of ring.

(7) Finish rear face to thickness, including latch-cover, and give clearance on front face.

(8) Drill and slot hole for stop, between lugs, and fit stop. (The long sides of this hole taper .007 inch in a length of 3 inches, the inner opening being the narrower.) Drill hole for screw, and counter-bore for head of screw, on front face, tap for screw and insert stop and screw.

(9) Bore inner end of stop to fit recess in block, and cut pitch of thread of block on rear face of stop. The front surface of stop has a clearance between it and the surface of recess in block, and hence does not require to be cut on it.

(10) Mill the curved surface of recess between lugs, with stop in place, and finish remaining surface between lugs by filing.

NOTE.—In order to make all carrier-rings and breech-blocks interchangeable, a jig should now be made representing exactly the breech of the gun, etc., with slotted threads. Another jig representing the breech-block should also be made. The carrier-rings are fitted to these jigs and the holes for hinge-pin reamed.

(11) If these jigs are not made, the carrier-ring is then fitted to the gun (which has been previously finished in rear, and has had the lugs for the hinge shaped out, and the hole for hinge-pin drilled), the holes for the hinge-pin in carrier-ring are finish-bored, using the hole in the gun as a guide.

(12) The exterior of lugs is rounded to shape and corners of carrier-ring rounded.

(13) The hole for the latch-pin is drilled from the inside, with latch-cover in place.

(14) The guides are slotted.

(15) The recess for latch-pin is milled in latch-cover and in carrier-ring, the hole for conical-pin is drilled in front face, and the holes through the guide-sectors.

(16) The recess for head of lever-handle is milled out.

III.—*The obturator-spindle (De Bange check).*

(1) Cut off rear end of stem of obturator to within 1 inch of finished length.

(2) Rough turn to within .05 inch of finished diameter and .05 inch of finished length.

(3) Finish turn-spindle and head.

(4) Cut thread on rear end of spindle.

(5) Face off to length, removing centers.

III.—(*a*) *The obturator-spindle* (*Freyre check*).

Same as for De Bange check.

IV.—*De Bange gas-check cups.*

FRONT CUP.

(1) Chuck, bore to size, finish front face, and turn exterior to fit accurately another chuck, made for the purpose. The exterior is left large enough to finish; about .08 inch above the finished size.

(2) Fit the chuck in the special chuck, with a driving fit, and finish rear face.

REAR CUP.

(1) Same as for front cup, except rear face is finished.

(2) Same as for front cup, except front face is finished.

(3) Both cups are then placed on an arbor with a disk between them, separating them the same distance as when the pad is in place, and the exterior of both cups is turned to fit gas-check seat in gun.

V.—*Freyre gas-check ring.*

(1) Chuck, bore, finish rear face, and turn outside to fit accurately another chuck, made for the purpose. The exterior is left .05 inch larger than finished size.

(2) Fit the ring in the special chuck, with a driving fit, bore taper and grind ring to fit corresponding surface of head of obturator.

(It has been found that the gas-check works better if the ring is ground to the spindle in such a manner that it bears at the thin edge, but has a very slight clearance in rear.)

(3) Fit the ring on special mandrel and turn the exterior to fit gas-check seat in gun, leaving a very slight excess for grinding to seat; turn grooves in exterior.

(4) Grind the ring to fit its seat in the gun. This grinding is continued till the head of the lever-handle passes .20 inch beyond its proper position when the block is closed. To test this the stop must be removed from carrier-ring.

VI.—*Obturator-spring* (*De Bange*).

(1) Bore to size.

(2) Put on mandrel, face to length, turn exterior diameter, and cut spring.

(3) Temper in oil.

NOTE.—The spring is made of tool steel. The length given in drawing is that to which springs are to be cut.

VI.—(*a*) *Obturator-spring* (*Freyre*).

Same as De Bange.

VII.—*Obturator-nuts* (*De Bange & Freyre*).

No special directions are necessary.

VIII.—*Latch-pin spring.*

(1) Wire is wound on mandrel of proper shape, and proper pitch given in winding.

(2) The wire is made fast at the end, and the spring heated slightly to set it into shape.

(3) It is cut off from mandrel, tapered at both ends to give a flat seat, and tempered in oil.

NOTE.—The spring is made of No. 16 B. and S. gauge piano wire, diameter .061 inch. It should compress in vise after tempering till coils are in contact without breaking.

IX.—*Lever-handle.*

(1) Rough turn to within .05 inch of finished size and face inner side of head.

(2) Finish turn for four (4) inches from finished side of head, taper from this point for a distance of 2.5 inches up to rough size.

(3) Finish plane-head to thickness and drill hinge-pin hole.

(4) Bend the handle and cut it off .05 inch long.

(5) Finish turn bent end, and finish the end by filing.

(6) Finish outside of head.

(7) Broach hole for pin, drill for securing screw, and finish file.

X.—*Latch-cover.*

(1) Bore ring .05 inch smaller, turn .05 inch larger, and face .01 inch thicker than finished dimensions.

(2) Cut in sectors of proper size, and plane to fit corresponding recess in carrier-ring.

(3) Fit to carrier-ring, and finish as explained under "carrier-ring."

XI.—*Latch-pin.*

This is made of the best Norway iron, and after finishing is case-hardened for about four hours. The recess in the front face of pin, in which the stud of base-ring acts, must be carefully located with reference to the top and bottom of the pin, and the dimensions of all parts must be strictly adhered to.

XII.—*The bronze-handle.*

The composition is by weight: 88 parts copper, 10 parts tin, and 2 parts zinc. The alloy must be made of new metals and must be sound and finish without defects on the surface. No special directions are necessary for the work. The handles are polished.

XIII.—*The hinge-pin for carrier-ring.*

No special directions are necessary.

XIV.—*The hinge-pin for lever-handle.*

(1) Rough turn to diameter of head.

(2) Finish turn largest and smallest diameters of pin, leaving metal for head.

(3) Mill flats and finish to length.

(4) Chuck and turn head eccentrically and mill exterior of head to shape.

XV.—*Latch-pin stud.*

This is made of tool steel, hardened only on the conical surface.

The stud must be accurately located and for this purpose a jig is used.

XVI.—*Rear sight socket.*

No special directions are necessary.

XVII.—*Vent-bushing.*

These are made of rolled copper.

No special directions are necessary.

ASSEMBLING THE PARTS.

(1) The guns are to be assembled by heat shrinkage and the parts must not be heated beyond the temperature required to give the amount of expansion requisite to enable them to be placed in position safely.

(2) The maximum expansion for all parts is .03 of an inch greater than the largest diameter of the surface over which the heated part passes. If possible, heating the parts in a wood fire or in direct contact with the fuel must be avoided, as it produces unequal heating and expansion; a hot air or gas furnace of some kind will be employed.

(3) The end contact of the parts must be as perfect as possible, and to insure this, pressure must be used, which will keep the joints accurately closed while the heated part is cooling.

(4) Water will be used to cool the parts. This will be applied by a ring encircling the heated part, so as to cool uniformly all around. The cooling must begin at the joint between the hot and cold part, and progress gradually to the further end of the heated part. The end pressure for securing a close joint must be kept up till the hoop is cool.

(5) After the parts have been prepared the tube is suspended, muzzle down, in such a manner that it may be conveniently handled and brought exactly over the heated jacket when the latter is in position.

(6) The jacket is now heated till the prescribed degree of expansion is reached, when it is removed from the furnace and placed, breech up, in a position where the tube can be lowered into it.

(7) The tube is then lowered into the jacket, and it is generally advantageous to allow it to descend rapidly for the last few inches as by this means a good contact at the shoulder is insured.

(8) It is not necessary to apply pressure to keep the tube in place in the jacket as the weight of the tube will accomplish this, but pressure may be applied if thought desirable.

(9) As soon as the tube strikes the shoulder of the jacket water is applied on the outside of the latter by the ring, and this ring is held slightly in rear of the shoulder, so that the jacket in cooling may tend to draw down on the shoulder.

It has not been found necessary in practice to prevent the water from running over the forward end of the jacket.

(10) When the jacket is cool the gun is returned to the lathe and the locking-shoulder on the jacket finish turned to prescribed dimensions. If the mark before prescribed has been carefully and accurately laid off

on the tube the length of the shoulder on the jacket is now laid off from it.

(11) The gun consisting of tube and jacket is now suspended as the tube was before, the trunnion-hoop heated till the prescribed degree of expansion is reached, when it is removed from the furnace and placed shoulder up in a position where the tube and jacket can be lowered into it.

(12) The tube and jacket are then lowered through the trunnion-hoop, the end pressure applied as soon as the trunnion-hoop and jacket are in their proper positions, and the water turned on at the joint as soon as possible.

(13) The gun consisting of tube, jacket, and trunnion-hoop, as soon as the latter has cooled, is placed on its breech end in a vertical position, the sleeve heated to the proper degree and placed in position by lowering it over the muzzle. Pressure is applied as soon as the sleeve and trunnion-hoop are in contact and water turned on at the joint as soon as possible.

(14) The gun is then returned to the lathe, the reverse cone for the key-ring turned and the recess for the locking-ring.

(15) The locking-ring is inserted with a driving fit, and its exterior turned to size.

(16) The gun is then placed in the same position as for assembling the sleeve, the key-ring is heated and dropped over the muzzle into place, the pressure is applied and water turned on at the joint as in the case of the sleeve.

Finishing after assembling.

(1) True up bearings and finish bore, using two cuts. First cut 3.15 inches, second cut 3.20 inches.

(2) True up bearings again if necessary, as the gun sometimes springs in boring; finish bore powder and shot chamber, and gas-check seat.

(3) Bore jacket for base-ring, face off rear end of tube to length, and cut thread for base-ring.

(4) Insert base ring, and screw it home. In this condition its front face should be in contact with the rear face of the tube, and its center line should be .25 inch to the left of the center line of the gun.

(To insure this position of the center lines a templet is made, one end of which is flush with the front face of base-ring, while the other end fits accurately into the thread along the center line of base-ring. After facing off the rear end of tube, the counter-templet is applied to the rear end of jacket, so that its inner end rests against the rear face of the tube .25 inch to the left of the center line of jacket. This counter-templet will then give a point of the thread in jacket.)

(5) The base-ring is then unscrewed, the rear end of the jacket heated by placing a hot ring of metal around the exterior, and the base-ring inserted again and screwed home till the center lines coincide.

(6) Face off rear end of base-ring to dimensions, and finish bore and face rear end of jacket.

(7) Rifle.

(8) Drill hole for hinge-pin of carrier-ring, and holes for end of lever-handle and for retracting-stud. These holes should all be located and drilled by using a jig.

(9) Finish turn.

(10) Plane out for lug of carrier-ring and for rear sight socket. Finish lug and insert securing-pin.

(11) Fit breech mechanism.

(12) Drill and tap for vent-bushing and front sight and insert vent-bushing.

(13) Weigh and stamp gun.

II.

DESCRIPTION OF THE 3.20-INCH STEEL B. L. FIELD GUN, MODEL OF 1889.

So many changes have been made in this gun since the first experimental one was built, in 1884, that it is thought proper to furnish a new description of the gun and its mechanism.

Principal dimensions.

Total length	inches	90.70
Length of tube	do	85.20
jacket	do	27.15
trunnion-hoop	do	8.80
sleeves	do	13.30
key-ring	do	3.00
rifling	do	70.925
powder chamber	do	10.00
shot chamber	do	2.073
front slope shot chamber	do	0.20
rear slope shot chamber	do	0.20
gas-check seat	do	1.56
cylinder	do	0.44
breech recess	do	4.00
trunnions	do	2.70
breech-block	do	6.10
breech-block and mushroom, De Bange	do	7.70
breech-block and obturator, Freyre	do	6.85
Diameter of exterior maximum	do	9.56
front of key-ring	do	6.56
tube in front of key-ring	do	5.60
tube minimum	do	4.60
trunnions	do	3.80
powder chamber maximum	do	3.80
shot chamber	do	3.32
cylinder rear of powder chamber	do	3.40
bore across lands	do	3.20
Depth of grooves	do	0.05
Width of grooves	do	0.30
lands	do	0.1188
Number of grooves		24
lands		24
(Twist uniform, one turn in 30 calibers.)		
Weight of gun	pounds	829
Preponderance	do	50
Weight of charge	do	3.75
projectile	do	13.5

Parts of the gun.

The gun is composed of—

1 tube,
1 jacket,
1 trunnion-hoop,
1 sleeve,
1 key-ring,
1 locking-ring,
1 base-ring,
1 vent-bushing,

and the various parts of the breech mechanism.

Details.

The tube enters the jacket from the rear and has a shoulder upon it, which is in contact with a corresponding shoulder in the jacket. This shoulder prevents any forward movement of the tube or rear movement of the jacket.

The trunnion-hoop carries the trunnions and is locked to the forward part of the jacket by a lip on the jacket and a corresponding shoulder on the hoop.

The sleeve is assembled in front of the trunnion-hoop but is not locked to it, the joint between them being plane.

The sleeve strengthens the tube.

The key-ring is assembled in front of the sleeve. A locking-ring is first inserted in front of the sleeve in a recess in the tube, and the key-ring is then assembled over the locking-ring and abutting against the sleeve.

The shape of the interior of the key-ring is an inverted cone, its smaller base being towards the sleeve. It acts thus to lock the parts in place and to prevent any movement.

From the front of the key-ring the tube tapers to the muzzle which ends in a swell.

The exterior shape of the gun is made up of a series of tapering surfaces, terminating at the muzzle as stated above.

On the interior of the gun, starting at the rear end, there is first the seat for the carrier-ring in the jacket; the base-ring is screwed into the jacket and held by a securing-screw from turning. This ring contains the slotted and threaded sectors for holding the breech-block.

In front of this is the tapering gas-check seat in the tube, and forward of this is a cylindrical surface leading to the powder chamber.

The powder chamber is an ellipsoid, and is connected with the shot chamber by a slope. The shot chamber is cylindrical and connected with the bore by a slope also.

The vent enters 12.50 inches from the rear face of jacket and at the maximum diameter of the powder chamber.

THE BREECH MECHANISM.

The principal parts are—

The breech-block.
The carrier-ring.
The obturator.
The lever handle.
The bronze-handle.

The breech-block.

Its principal parts are—

The threaded sectors.
The slotted sectors.
The obturator spindle recess.
The lever-handle lugs.
The nose.
The stop groove.
The latch groove.
The locking recess.
The guide groove.

The threads of the block are removed along three sectors, as usual in the interrupted screw fermeture, to allow the block to slide in the corresponding slotted sectors of the base-ring. The threaded sectors engage in the corresponding slotted sectors of the breech-block.

The obturator spindle recess contains the stem of the obturator with its spring and nut.

The lever-handle lugs carry the lever-handle. On the right lug is a projection which forms a stop and limits the motion of the lever-handle.

The nose is the front part of the block where the diameter is reduced to allow the block to enter partly the gas-check seat.

The stop groove, into which the stops enters, is on the left side.

The latch groove is in two parts, one longitudinal at the front end of the block, and the other transverse at the rear end. The stem of the latch drops into the front groove when the block is withdrawn, and into the rear groove when the block is revolved into its firing position, in each case unlocking the carrier ring.

The locking recess is at the front end of the longitudinal latch groove. The stem of the latch drops into it when the block is withdrawn, and thus locks the block positively to the carrier-ring.

The guide groove is the cylindrical recess at the rear of the block in which the guide sectors move when the block is rotated.

The Carrier-ring.

The principal parts are—

The guide sectors.
The latch-cover.
The latch.
The latch-spring.
The stop.
The hinge-pin.
The bore.
The exterior taper.
The lugs.

The guide sectors—These are three projections from the interior of the carrier-ring, which fit in the slotted sectors of the breech-block and guide it during its motion through the carrier-ring.

The latch-cover is a separate piece, which covers the latch and its spring, and is secured to the carrier-ring by two screws. On removing this plate the latch and spring can be taken out.

The latch fits in a recess in the carrier-ring. It is acted on by a spring, which pushes it constantly toward the axis of the carrier-ring. Its inner end or stem rests on the surface of one of the slotted sectors, except at the ends of its travel, when it drops into the corresponding recesses in the block. As long as its stem rests on the surface of the sector its outer end or nose projects beyond the exterior surface of the carrier-ring, and, entering a recess in the jacket, locks the carrier-ring to the jacket. When the stem drops into its recesses, the nose of the latch is withdrawn by the action of the spring and the carrier-ring unlocked.

The front face of the latch has a recess, into which fits a hardened stud, in the rear face of the base ring. This stud acting against the recess lifts the latch out of its locking recess in the breech-block and holds it in a position such that the stem can pass up the inclined groove. In order that the stud may act on the latch, a hole is drilled through the front face of the carrier-ring, for the stud to pass through.

The functions of the latch-spring have been already explained.

The stop enters the carrier-ring on the left side between the lugs, and projects beyond the bore of the carrier-ring, entering a groove in the breech-block which is cut for it. This stop limits the travel of the block to the rear in withdrawing it, and also limits its rotation.

The hinge-pin enters the lugs of the carrier-ring and a corresponding lug on the jacket, and the carrier-ring swings around it in opening.

The bore is the diameter of the ring across guide-sectors.

The exterior taper forms the surface of contact of carrier-ring with jacket.

The lugs are the bearings for the hinge-pin.

The carrier-ring, as its name indicates, carries the breech-block when the latter is withdrawn, and by means of it the block may be swung round out of the way for loading.

The obturator.

Either the De Bange or the Freyre obturator may be used in these guns.

De Bange obturator.—The principal parts are—

The spindle.
The front cup.
The rear cup.
The pad.
The spring.
The nut.
The spline screw.

The spindle has a mushroom-shaped head, and a stem, which extends through the breech-block and terminates in a screw-thread. The block is recessed correspondingly.

The front and rear gas-check cups are of steel, and they hold between them a plastic pad made of certain proportions of asbestus and tallow and covered with canvas.

A spiral spring surrounds the stem of the obturator at the rear of the block, and bears against a shoulder on the block and a nut on the screw-thread of the spindle. This spring keeps the cups and pad in place, takes up any set of the pad due to firing, and prevents the fracture of the screwed end of the stem.

The spline screw holds the nut on the spindle in position and prevents its unscrewing when the pad sticks in its seat after firing, and the block is rotated by the lever-handle.

Freyre obturator.—The principal parts are—

The spindle.
The gas-check ring.
The spring.
The nut.
The spline screw.

The spindle has a head at the forward end, its front surface being plane and its sides conical, with the larger diameter of the cone in front.

The gas-check ring is nearly triangular in section, coming to a point at the front. It fits accurately on the conical surface of the head of the spindle, and is slightly longer in the direction of the axis of the bore than this head. Its rear surface rests against the front surface of the block, while the rear surface of the head is not in contact with this front surface, and can only be brought in contact with it by a heavy pressure, which will expand the gas-check ring.

The spring acts against a shoulder in the block and a corresponding shoulder on the obturator-spindle, and tends to press the spindle forward. In the De Bange system the spring acts to press the spindle back.

The nut prevents the action of the spring from forcing the spindle too far forward, and also regulates the tension of the spring. It is in the same position as in the De Bange system.

The spline screw acts as in the De Bange system.

The lever-handle.

This acts as a lever to rotate the block, its head acts as a cam to withdraw the block and obturator when the latter sticks after firing, and to lock the block in the carrier-ring and prevents rotation during firing. It is supported in the lugs of the breech-block by a pin and rotates with the pin. It is secured to this pin by a screw entering vertically. The head of this pin has a projection which strikes against the corresponding stop on the right lug and limits the motion of the lever-handle.

The bronze-handle.

This is attached to the breech-block by two screws. Its purpose is to assist in withdrawing and pushing in the block.

Action of the breech mechanism.

Suppose the breech closed and the gun ready for firing. In this position the threads of the breech-block are engaged in the threads of the base-ring; the gas-check is in its seat; the lower end of the latch is at the end of the transverse groove in the block; the nose of the latch is withdrawn from its recess in the jacket, and the carrier-ring is unlocked; the lever-handle is vertical, its cam in the recess in the carrier-ring, and its lower end in the recess in the jacket.

To open the breech: Grasp the lever-handle with the left hand, thumb down, and raise it till it strikes the stop, then rotate the block as far as possible to the left; lower the lever-handle, its cam acting against the surface of the carrier-ring will withdraw the gas-check if it sticks in its seat. This rotation of the block pushes the latch into its recess and locks the carrier-ring to the jacket. Grasp the bronze-handle with the right hand, thumb to the right, and withdraw the block till it comes up against the stop. In this position the stem of the latch drops into the locking recess, locking the block to the carrier-ring, and at the same time unlocking the carrier-ring from the jacket. Swing the block and carrier-ring around to the left, and insert the projectile and charge.

To close the breech: Seize the bronze-handle with the right hand, thumb to the right, and swing the carrier-ring and block around till the carrier-ring is in its seat, grasping the lever-handle with the left hand, thumb down, at the same time, and raising the handle till it strikes the stop. The carrier-ring should be brought up to its seat sharply, but without slamming, and should be held firmly for an instant, otherwise the ring may start back slightly from the jar, and the retracting-stud fail to hold the latch high enough to allow the block to move forward.

When the carrier-ring strikes its seat the retracting-stud enters the hole in the front face of the ring, and acting on the recess in the latch lifts the latch to its traveling position, that is, lifts it out of the locking recess and holds it in such a position that when the block is pushed forward the lower end of the latch will strike the inclined surface at the front of the longitudinal groove.

Raise the lever-handle till it rests against the stop, and push the block forward till it stops.

During this travel the lower end of the latch has moved up the inclined surface of the longitudinal groove, and has locked the carrier-ring to the jacket.

Revolve the block one-sixth of a turn till it strikes the stop; lower the lever-handle to its proper position, when everything will be in the condition first described, and the gun will be ready for firing.

When the block is revolved one-sixth of a turn the lower end of the latch gradually drops into its groove, unlocking the carrier-ring, which remains so during firing.

Respectfully submitted.

CHARLES SHALER,
Captain of Ordnance, President.
LAWRENCE L. BRUFF,
Lieutenant of Ordnance, Recorder.

NOMENCLATURE OF THE 3.2-INCH B. L. STEEL RIFLE.

3.2-INCH GUN.

Parts of gun.

Tube.
Jacket.
Trunnion-hoop.
Sleeve.
Key-ring.
Base-ring.
Locking-ring.
Vent-bushing.
Securing-screw.
Retracting-stud.
Rear sight socket.
Breech mechanism.

Parts of tube.

Rear face.
Gas-check seat.
Cylinder.
Powder chamber.
Rear slope.
Shot chamber.
Front slope.
Bore.
Grooves (24).
Lands (24).
Exterior shoulder.
Locking-ring recess.
Key-ring cone.
Chase.
Neck.
Swell.
Face of muzzle.

Parts of jacket.

Rear face.
Lever-handle recess.
Carrier-ring lug.
Carrier-ring hinge pin-hole.
Carrier-ring seat.
Latch recess.
Rear sight socket seat.
Base-ring screw-threads.
Securing-screw recess.
Shoulder.
Locking-lip.
First taper.
Second taper.
Third taper.
Fourth taper.
Vent seat.
Vent-seat threads.

Parts of trunnion-hoop.

Locking-lip.
Trunnions.
Rim-bases.
Front sight mass.

Parts of key-ring.

Locking-ring recess.
Interior taper.

Parts of base-ring.

Rear face.
Exterior threads.
Slotted sectors.
Threaded sectors.
Securing-screw recess.
Retracting-stud seat.

Parts of vent-bushing.

Vent.
Inner cone.
Threads.
Square.

Parts of securing-screw.

Threads.
Shank.

Parts of retracting-stud.

Threads.
Shank.
Cone.

Parts of rear sight socket.

Socket.
Socket-screw.

Parts of breech mechanism.

Breeck-block.
Carrier-ring.
Obturator.
Lever-handle.
Bronze-handle.

Parts of breech-block.

Rear face.
Obturator-spindle recess.
Obturator-nut recess.
Obturator-spring recess.
Lever-handle lugs.
Lever-handle pin-hole.
Lever-handle stop.
Bronze-handle screw-holes.
Front face.
Nose.
Threaded sectors.
Slotted sectors.
Stop groove.
Latch groove.
Locking recess.
Guide groove.

Parts of carrier-ring.

Rear face.
Lever-handle recess.
Lugs.
Hinge-pin.
Hinge-pin holes.
Hinge-pin securing-screws.
Counterbore.
Guide sectors.
Air holes.
Latch-cover.
Latch-cover screws.
Latch.
Latch recess.
Latch-spring.
Stop.
Stop-seat.
Stop-screw.
Front face.
Clearance.
Retracting-stud hole.
Exterior taper.

Parts of obturator—De Bange.

Spindle.
Front cup.
Rear cup.
Pad.
Spring.
Nut.
Spline-screw.

Parts of obturator—Freyre.

Spindle.
Gas-check ring.
Spring.
Nut.
Spline-screw.

Parts of spindle—De Bange.

Mushroom head.
Stem.
Screw-thread.

Parts of spindle—Freyre.

Head.
Stem.
Screw-thread.

Parts of lever-handle.

Head.
Cam.
Pin.
Securing-screw.

Parts of bronze-handle.

Handle.
Screws.

Parts of latch.

Stem.
Nose.
Retracting-stud recess.
Shoulder.

Parts of lever-handle pin.

Head.
Journals.
Flats.
Securing-screw hole.

Plate I.

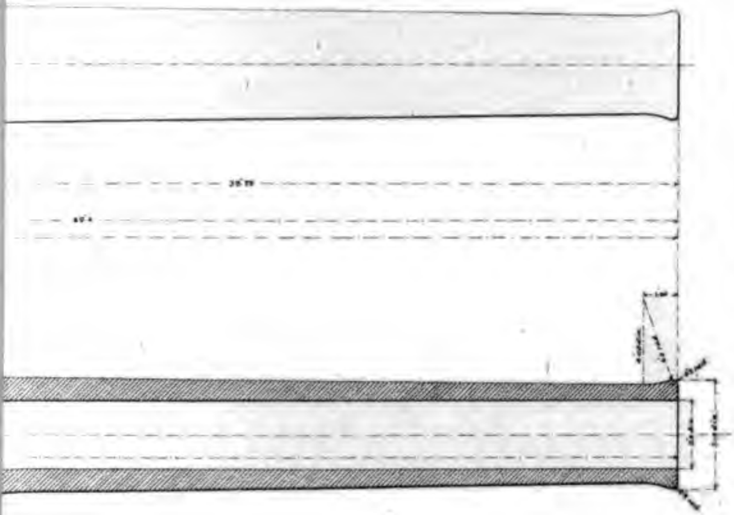
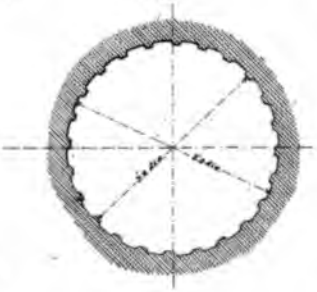


Fig. 7.

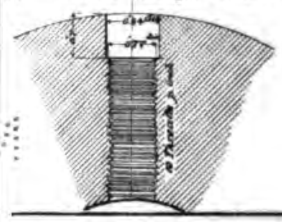


Rifling.

No. of Lands	24.
" " Grooves	24.
Width of Lands	0.1188
" " Grooves	0.3
Depth " "	0.05

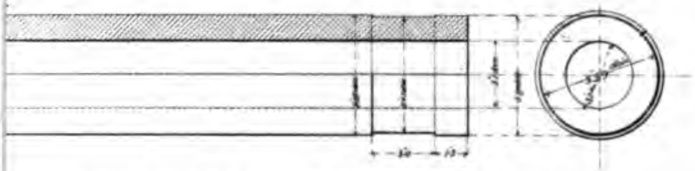
Twist uniform, 1 turn in 30 cals.

11, Section through centre of Vent



For the Board
Charles Shaler
Captain of Ordnance.

Appendix 14, 1889.



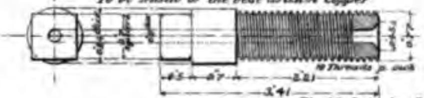


Fig 14, Copper Vent-Bushing
To be made of the best drawn Copper

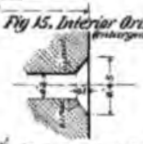


Fig 15, Interior Orifice
(enlarged)

Fig 5, Trunnion Band.

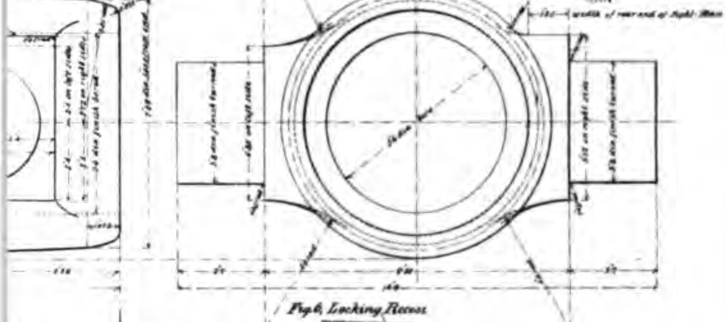
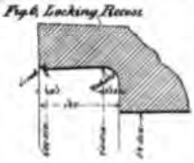


Fig. 6, Locking Recess



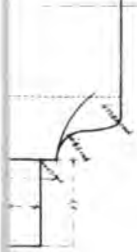
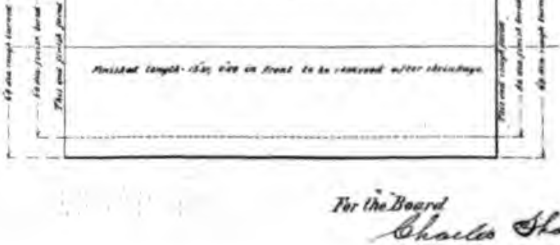


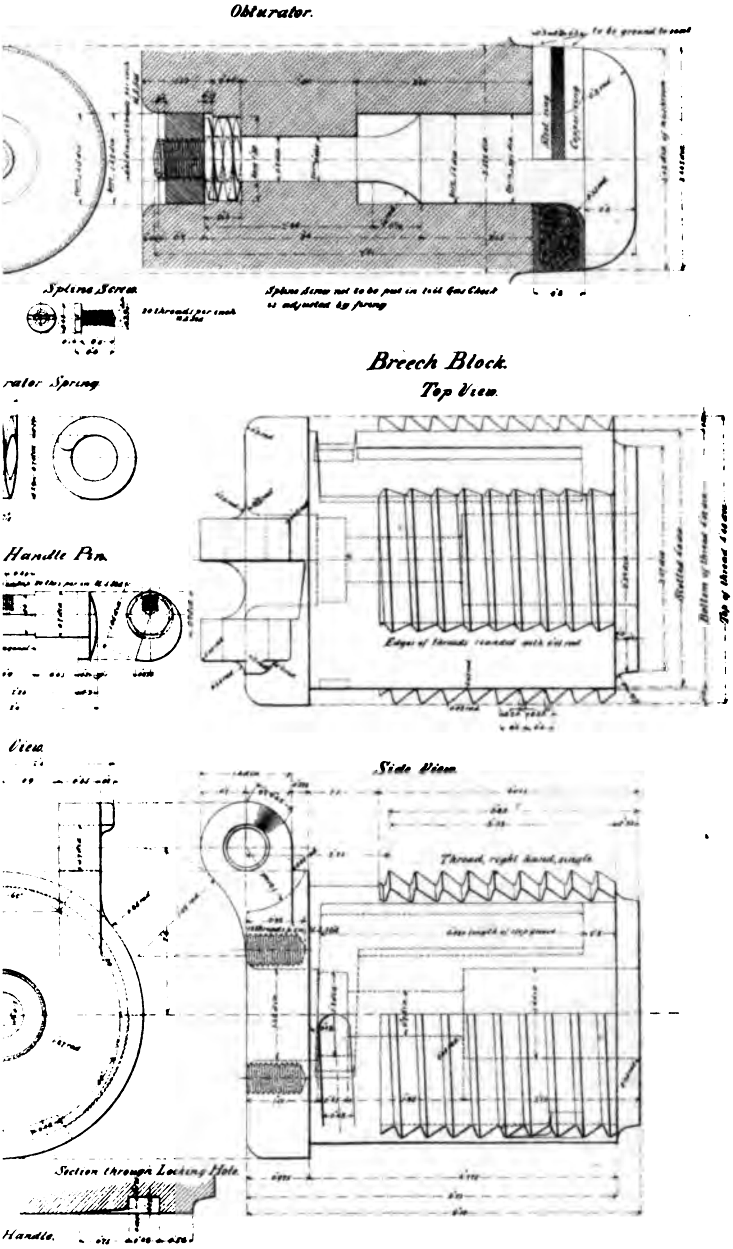
Fig. 13, Sleeve.


15.0
This end finish faced
Finished length 15.0; 0.3 in front to be removed after shrinkage.

For the Board
Charles Shaler
Captain of Ordnance.

War51 1

Plate III.

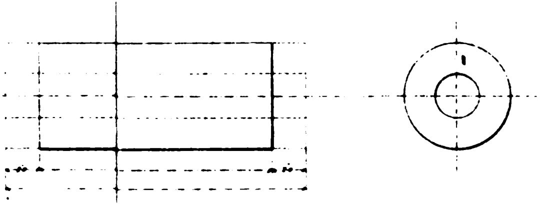


For the Board
Charles Shaler
Captain of Ordnance.

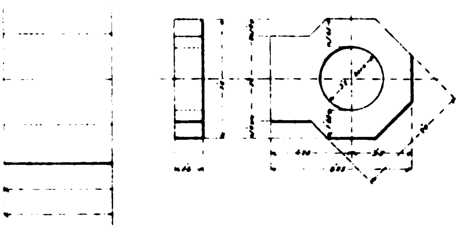
Appendix 14. 1889.

Plate IV.

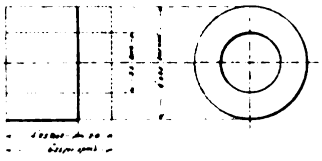
Watervliet Arsenal, June 5

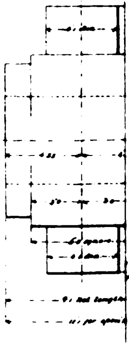


Carrier Ring.



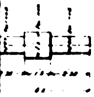
Base Ring.



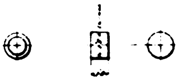


ever Handle Pins.

One forging - 2 Pins

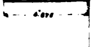


Nut.



Rear Sight

Hinge



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For the Board

Charles Shaler

Captain of Ordnance

War51 1

Appendix 14, 1889.

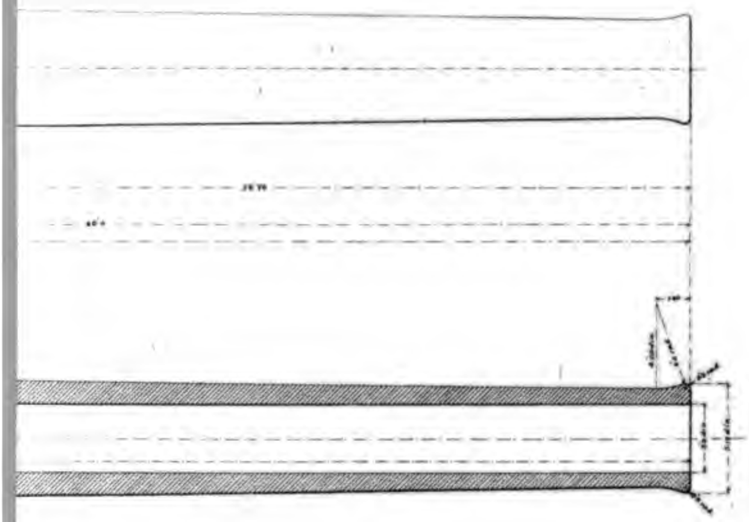
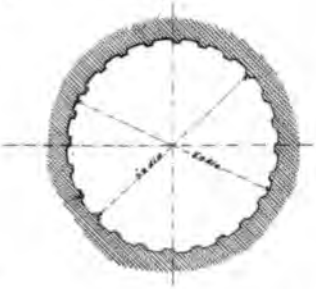


Fig. 7.

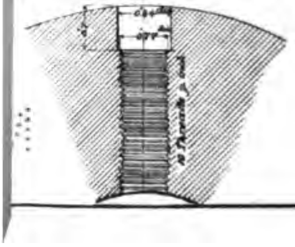


Rifling.

No. of Lands	24.
" " Grooves	24.
Width of Lands	0".1188
" " Grooves	0".3
Depth " "	0".05

Twist uniform, 1 turn in 30 cals.

11, Section through centre of Vent



For the Board
Charles Shaler
Captain of Ordnance.

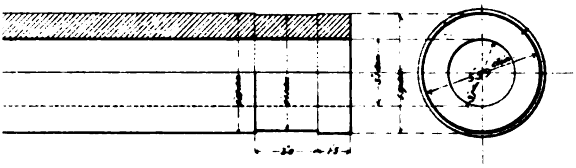


Fig 14, Copper Vent-Bushing

To be made of the best drawn Copper

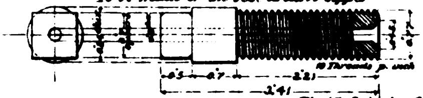
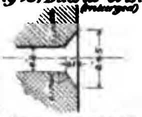


Fig 15, Interior Orifice (enlarged)



Trunnion Band.

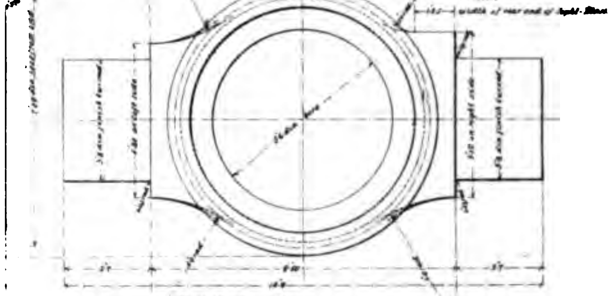


Fig 6, Locking Recess

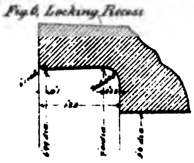
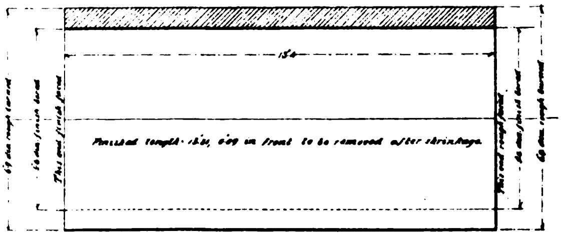


Fig 13, Sleeve.

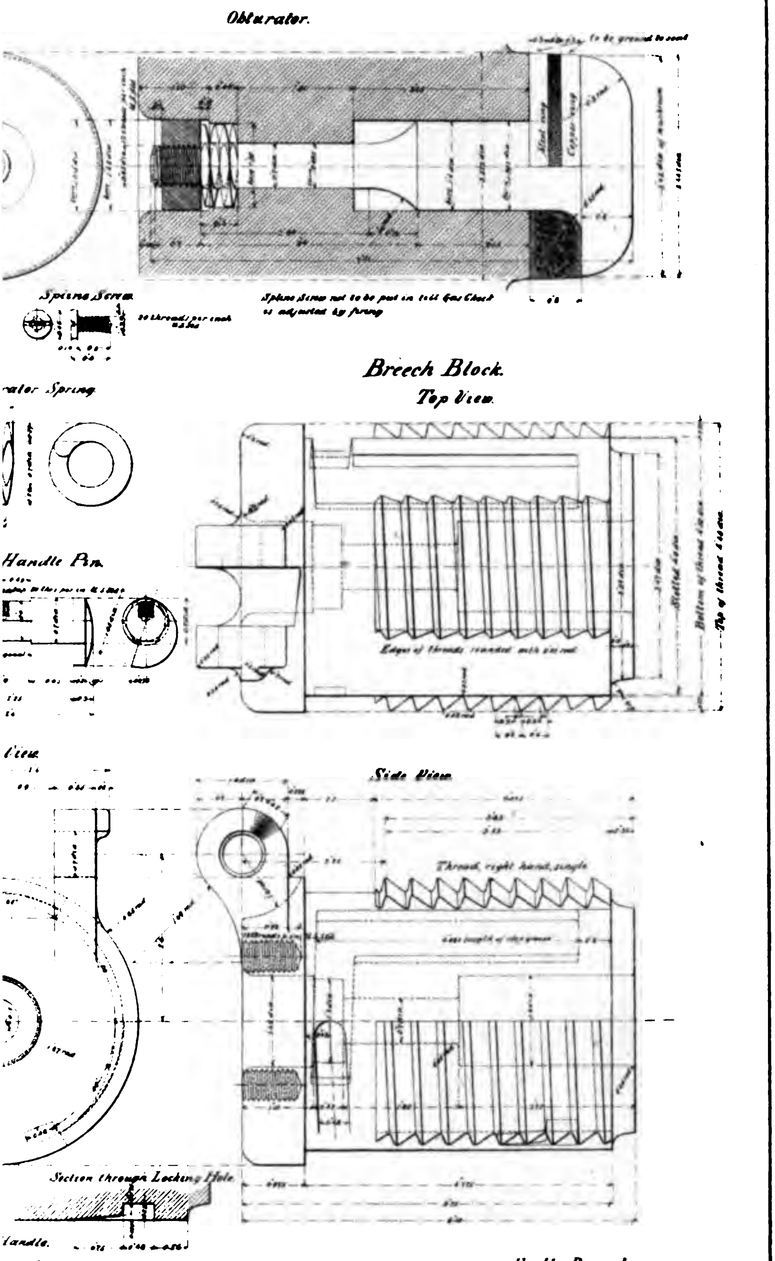


For the Board

Charles Shaler

Captain of Ordnance.

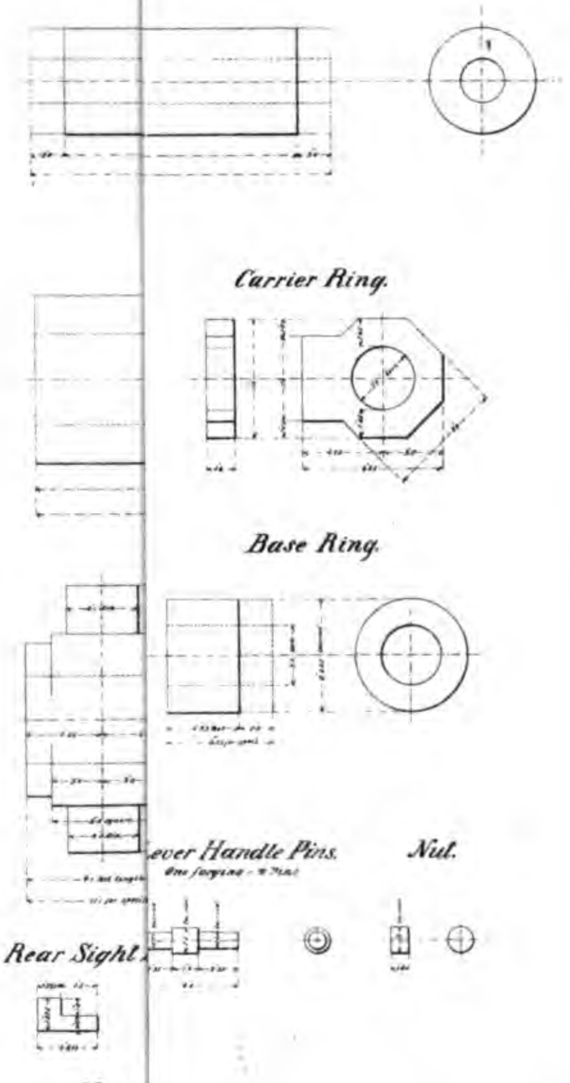
Plate III.



For the Board
Charles Shaler
Captain of Ordnance.

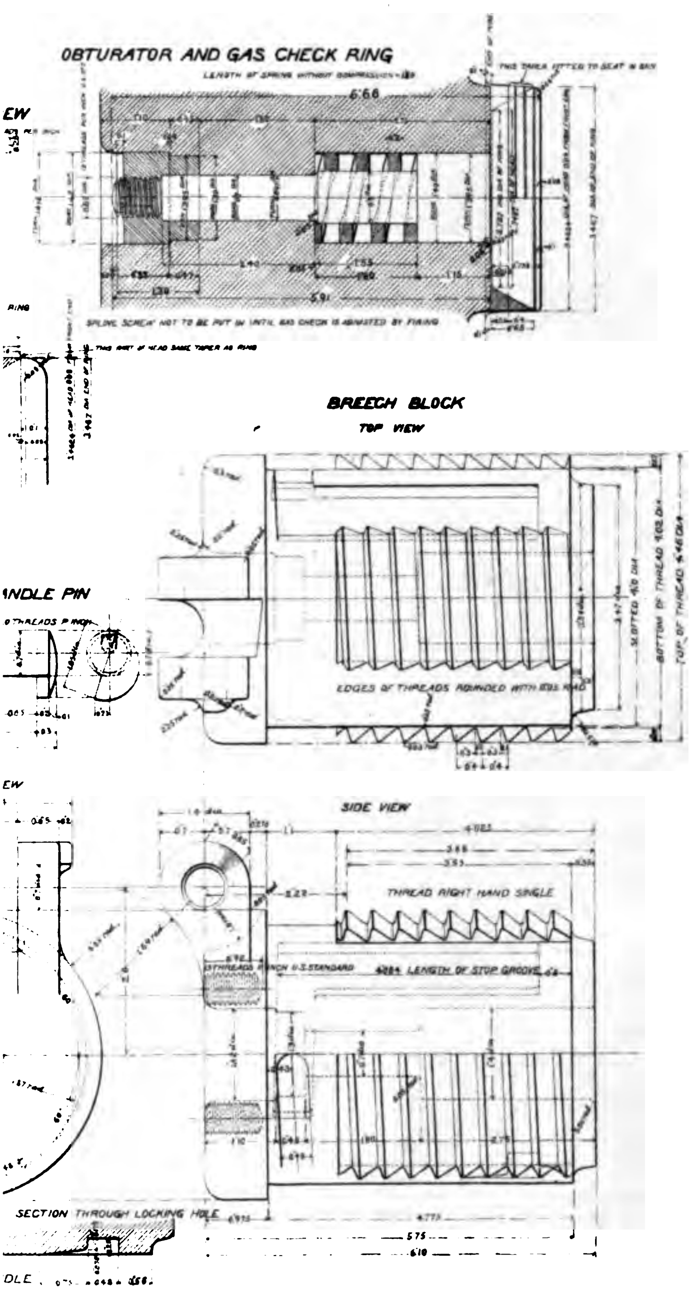
Appendix 14. 1889.

Watervliet Arsenal, June 3



For the Board
Charles Shaler
Captain of Ordnance

Plate V


OBTURATOR AND GAS CHECK RING
LENGTH OF SPRING WITHOUT COMPRESSION
6.66
5.91
1.55
1.15
THIS TAPER FITTED TO SEAT IN GUN
SPLINE SCREW NOT TO BE PUT IN UNTIL GAS CHECK IS ADJUSTED BY FIRING
THIS PART OF HEAD SAME TAPER AS RING
EW
RING
BREECH BLOCK
TOP VIEW
EDGES OF THREADS ROUNDED WITH .035 RAD
SLOTTED 4.0 DIA
BOTTOM OF THREAD 4.03 DIA
TOP OF THREAD 4.46 DIA
NDLE PIN
THREADS P INCH
SIDE VIEW
THREAD RIGHT HAND SINGLE
THREADS P INCH U.S. STANDARD
LENGTH OF STOP GROOVE
4.082
5.75
6.10
SECTION THROUGH LOCKING HOLE
DLE

For the Board
Charles Shaler
Captain of Ordnance.

Appendix 14, 1889.

APPENDIX 15.

REPORT ON THE CONSTRUCTION OF FIFTY 3.2-INCH FIELD-LIMBERS, ONE CAISSON, AND ONE COMBINED BATTERY WAGON AND FORGE, AT THE NATIONAL ARMORY, SPRINGFIELD, MASS.

(3 Plates.)

NATIONAL ARMORY, *July* 13, 1889.

The working drawings, nomenclature, and bills of materials for these carriages were forwarded to the Ordnance Office January 26,1889.

No alteration of field-carriages had been made to meet the changed condition of service since the civil war. The practical adoption of the steel field-gun carriage for 3.2-inch field-gun demanded the construction of corresponding carriages for a full equipment. This, under the authority of the Chief of Ordnance, of October 26, 1886, was begun at the National Armory some time after by the undersigned, with the assistance of Bvt. Col. and Maj. E. B. Williston, Third U. S. Artillery, whose practical knowledge of what is now required in the service, based upon a large experience during the civil war, well fitted him for such duty.

A system of harness, a radical departure from the old, devised by Colonel Williston for machine-gun service, and, while the work was in progress, improved by him, constituted a point of departure for the new constructions.

This harness required the abandonment of the pole-yoke of the old system and the use of the "splinter-bar" for attachment of traces. For the former, the neck-yoke, and for the latter, double and singletrees are substituted in the new system, which insures the required celerity in the attachment and detachment of the horses, and at the same time the least injury to them on the march and in action. The next element at hand for the basis of the construction was the steel field-gun carriage wheel, which had undergone the severe test to which the gun-carriage had been subjected. The gun-carriage wheel had to be for obvious reasons the wheel for the other carriages, although the fact that this wheel was heavy (heavier than the old 6 and 12-pounder wheels) was appreciated; but on the wheel, both on the gun-carriage and other carriages, must fall the most trying work, and its endurance should be placed beyond question.

This endurance was established by the tests given the gun-carriage, a lighter wheel having failed under much less severe trial. It was desirable also to have but one wheel for all mounted and horse-batteries, for which this wheel possesses the requisite strength. The degree of lightness necessary for the several services was to be sought rather in the bodies, axles, etc., of the carriages than in the wheels.

The Archibald wheel, a patented construction, made by the Archibald Wheel Company, of Lawrence, Mass., with malleable iron nave-boxes and flanges and steel tire, of the dimensions of the gun-carriage wheel, was therefore adopted.

It should be stated, however, that this action does not debar the use of a lighter wheel should one be worked up and proven by test to possess the requisite strength. It is not only possible but highly probable that this can be done, but it will require time that was hardly available at the beginning, and, when accomplished, to make the change will require but the taking off of one wheel and the putting on of the other, the remainder of the constructions being in nowise affected.

The wheels used in the test of the light gun-carriage, referred to below, had aluminum-bronze nave-boxes and flanges, weighing about 7 pounds per wheel less than the malleable iron. The makers intended that the weight should be about 12 pounds less, but their bronze-caster failed to produce what was desired, the castings being larger than the patterns. These wheels have undergone severe test, and there can be little doubt that had the wheels been as light as planned the result would have been the same. A wheel, therefore, of 188 pounds (about) may be regarded as having equal strength but greater cost than the wheel used.

On the ammunition chest would depend in a measure the dimensions of the other parts of the carriages. To carry the greatest amount possible of ammunition required the lightest possible construction, not only of the chest but of all other parts. Some experimental steel chests had been made, issued, and used in the service, but had been found unsuitable. Experiment had shown that steel chests, to be as light as the service demanded, would be no protection for the contents of the chests in action. On the contrary, a positive detriment from the ragged edges of the holes produced by penetrating shot, the holes also rendering the chests irreparable and non-waterproof. Metal chests were, therefore, not considered. A wooden chest of the lightest suitable material was a necessity. The black walnut used for the old chests was deemed unsuitable on account of its weight, and was further objectionable on account of cost, being now comparatively a rare wood. White wood, although a soft wood, when thoroughly ironed like the old chest, was deemed suitable, all things considered, for the service, and was used in the construction.

A solid steel axle that had been used with the Archibald wheel on one of the aforesaid experimental carriages, weighing 167½ pounds, was taken and reduced in weight by removing all superfluous metal. After this reduction the weight was 151 pounds, a gain of only 16½ pounds. About this time attention was called to a tubular steel axle, called the "National Wrought Steel Tubular Axle," made by the National Tube Works Company, of Boston (manufacturing plant at Boston and McKeesport, Pa.). Examination of this construction led to its adoption as not only in every way suitable with respect to strength and weight, but more economical than the solid axle.

The feature of the "pitch" of this axle, being obtained by bending at the center, was not particularly objectionable for limbers, caissons, and battery wagons, and forges. Beds called "coached bed," of cast-steel shrunk on, two forming the shoulders and these, with one in the center, the foundation for the superstructure and its attachment to the axle, offered all the means required for overcoming the difficulties of construction presented by said pitch. This axle is re-enforced by an interior tube at the shoulders and is three-eighths of an inch thick, weighing 126 pounds when finished for assembling, making a further gain of 25 pounds—total 41½ pounds less than the solid axle above mentioned. The light 3.2-inch field-gun carriage has an axle of this kind one-half inch thick. This was straightened at the Armory, the cast-steel shoulders replaced by wrought-steel, and the "pitch" given by bending at the shoulders. This carriage has been tested without injury with 500 full service charges, which test insures the requisite strength for the axle used for limbers, caissons, battery wagons, and forges.

For equal weights wood is the strongest material, but its bulkiness is objectionable for limbers and caisson bodies; besides, it is perishable, no matter how carefully kept and painted. Angle-iron was used, the compactness and shape of which contributed materially in furnishing the space and places for attachments, etc., for carrying the spare and other parts and intrenching tools, of which more are carried than in former constructions, but more weight, as a consequence of the use of iron or steel, was added. The said bodies were made as light as it was deemed possible for the work—indeed some risks have been taken in favor of lightness. Extreme simplicity, with the fewest possible number of parts and with the fewest possible number of detachable parts—there are properly but two, the pole-bolt and the crank-nut of the anvil-bolt, in all the carriages—compactness, facility, and rapidity of changing a pole and of attaching and detaching the spare parts, tools, implements, etc., generally of getting at and putting back everything carried in the least possible time, and the exclusion of every ounce of superfluous weight, constituted the motive governing the constructions.

There are no trays in the ammunition-chest, which has two transverse partitions, forming three compartments, two at the ends for projectiles, the middle one for cartridges. The projectile compartments have light cast bronze-metal packing, forming in each 21 receptacles for projectiles. Soft-wood packing on the bottom, on which the metal packing rests, and on the chest-lid above, hold the projectiles firmly when the lid is closed. Back of the packing on the lid (between it and the lid) is a well-protected place for carrying the breech-sight, and in this place (left-hand side) a wooden spring and blocking, forming a receptacle for the sight, have been placed.

The chests are covered with heavy cotton duck, which, before being put on, is thoroughly saturated with raw linseed oil and hung over a "horse" long enough for extra oil to drip off and to dry.

To get at the projectiles or cartridges, above which latter is space enough for carrying the two haversacks, nothing, after opening the chest, has to be moved. The cartridges and projectiles are at once exposed, and the chest being low, even a short man can readily reach any projectile or any cartridge of the top layer, and therefore can readily take out the projectiles in any order—that is, from right to left or from front to rear, or the reverse, so as to preserve or lessen the weight at the end of the pole. The projectiles being at the ends of the chest, and the center of gravity of the exceptionally low chest being considerably below its center, reduce the chances of overturning in action to a minimum. Beneath the chests, on the limbers, attached to the axles and hounds, one on each side, are water-tight cylindrical iron boxes with bronze screw-lids, for carrying unbroken boxes of primers and spare obturators—the broken boxes of primers, loose primers being carried in the trail-box of the gun-carriage with the gunners pouches. The front foot-boards of limbers are hinged to the rear ones, and provided with latches for securing them when down to the double-tree bolt-braces. Unlatched and raised up, a compartment—the "wheel-grease, oil-can, and tool-box compartment"—on the right, and the space between the hounds, fork, axle, and back of the splinter-bar on the left, are exposed, permitting the cans and tools to be taken out and rendering the pole-bolt and prop, and prop for end of pole (which is carried over the axle and fastened by a catch-spring to the left foot-board hinge), accessible from above, obviating the necessity of stooping or getting under the splinter-bar in changing a pole or letting down the pole-prop. The wheel-grease can, oiler, and tool-box just fill the space in the compartment. The oiler can be carried, if found more convenient, in the trail-box of the gun-carriage, which is large enough for the pouches, lanyards, loose primers, and oiler, with abundance of additional space for cotton waste with which the oiler should be liberally packed to prevent damage during recoil.

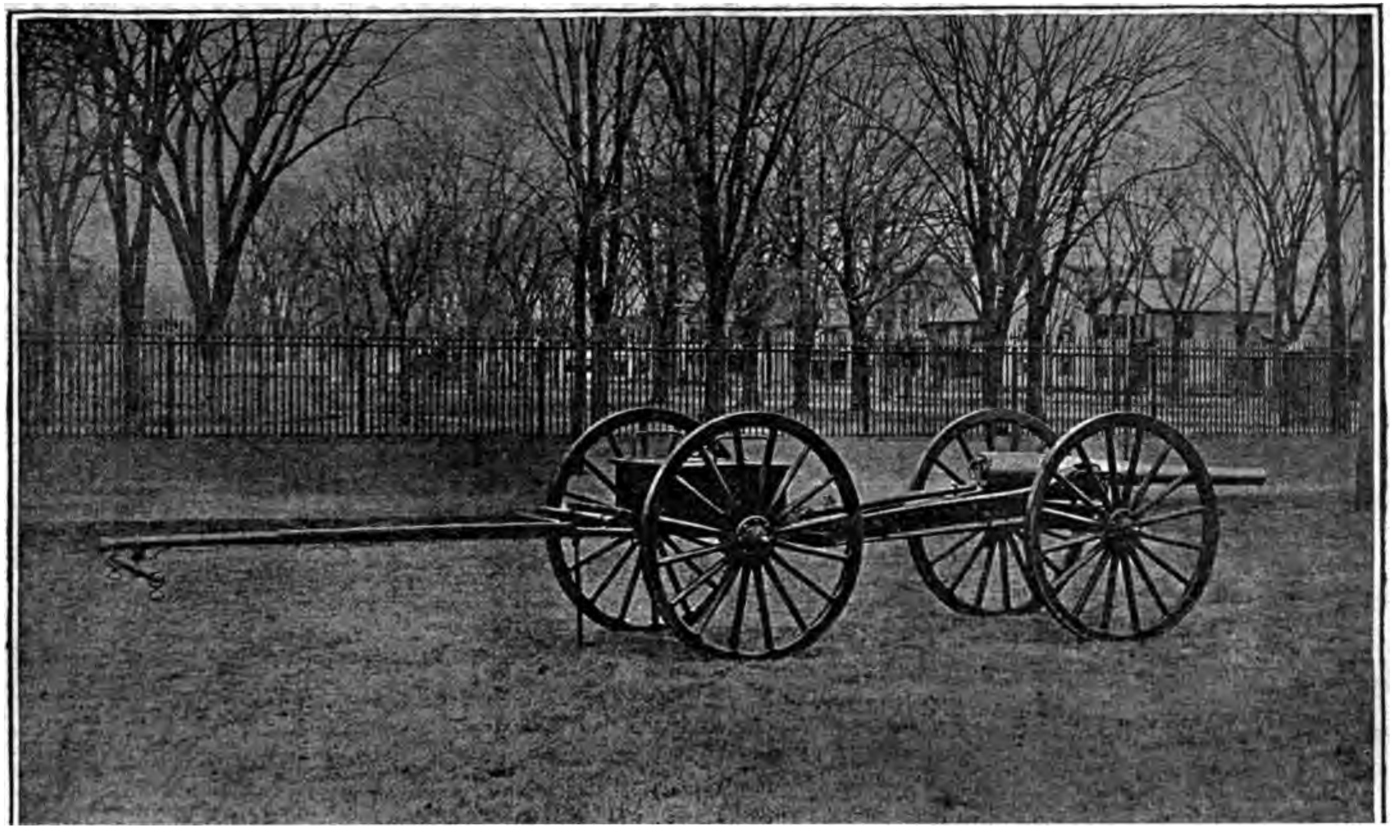
The limbers for the carriage, caisson, and battery wagon—the last-named constituting the forge—are in every respect the same, except the two cylindrical water-tight boxes for primers and obturators, which are omitted on the forge, and its chest has no metal or wood ammunition packing inside; the three compartments being used—the middle one for the portable forge, forge implements, and part of the tools and shoe-box, the right-hand one for horseshoes, and the left for the remaining tools and small stores, such as horseshoe nails, small bolts, nuts, etc., to carry which two small canvas bags are provided. For the coal, a large, strong cylindrical canvas bag, capacity about 3 bushels, is provided. This, when containing coal, is to be carried on the foot-boards, whose length it about equals, lashed to the chest-handles by stout cords, permanently attached to the bag, one of them being the cord by which the mouth of the bag is drawn together and secured. When empty the bag can be carried inside the chest. The tools and parts of the forge are so arranged and secured by the attachments that any one can be taken out without disturbing the others, except some parts of the forge that are needed only after the forge itself is removed; these are packed under the forge, and thus secured from being misplaced. A padlock and key for the chest secures to the blacksmith the exclusive control of the forge and tools.

The dimensions and construction of the iron bodies of caisson and battery wagon are the same. The holes and staples for securing the chests, the spare wheel-axle, the "floor-rods," foot-boards, and various attachments for securing spare pole, intrenching tools, etc., of the former are wanting on the latter, which has its own peculiar holes and attachments for the wooden body and parts carried.

The battery wagon and forge constitute one carriage; the fore-wheels carrying all except the sledge, anvil, and vise, that pertains to the forge; the hind-wheels all that pertains to the battery wagon, and in addition the tools just stated, belonging to the forge.

This combination was made possible by the changed conditions of construction and transportation and modified views, based on war experience, of the amount of material and parts to be carried for repairs.

The advantage of one carriage less in a battery is apparent, but the full benefit can not be obtained, as another carriage, called an "artillery store-wagon," is added. The gain, however, is considerable, viz: two horses, two drivers, one set of lead harness, and three saddles, the wagon being but a four-horse wagon, to be driven with reins, by one man seated in it. The function of this wagon is to carry ammunition for the small-arms of the battery, spare small-arms not in use, spare intrenching tools, water-barrel, and the knapsacks of cannoneers. These last are entirely out of place on the limbers and caissons, both on the march and in action. On the march, if so carried, about 3,000 pounds



would be added to the battery, impairing its mobility; in action, besides the additional weight, they would be an obstruction to the battery's efficiency and exposed to possible destruction or loss. The knapsack, never going into action, would reasonably insure its benefit to the cannoneer at all times.

The battery-wagon body, made of whitewood and oak, has three compartments; the lids, one on each side, on top, opening into one—the largest—and a door on the front end into the other two of equal size, each containing a chest which just fills it; one chest containing the saddler's tools, the other the carpenter's and wheelwright's. In these chests the tools are so arranged that each can be taken out without disturbing the others, with one exception; in the carpenter's and wheelwright's chest the smoothing-plane must be removed to get out the jack-plane.

In addition to the space in these chests occupied by the tools, there is enough for small stores, to carry which two small canvas bags are provided for each chest. Locks and keys secure for the saddler and wheelwright exclusive control of respective chests, which are provided with chest-handles for removing them from the wagon and carrying them about.

The anvil, which is carried on the middle rail between the door of the chest compartment and the front cross-bar (secured by a bolt passing through the body of anvil and the middle rail, and a crank-nut), affords support to said door, in addition to that of the two bolts on it, from the thrust of the chest in going down hill. In the largest main compartment of the battery wagon are carried the grindstone and stand (compactly packed by permanent fixtures over the right tool-chest compartment, immediately under and secured by the right lid), a coal-oil can and a sperm-oil can (both carried securely packed by permanent fixtures over the left tool-chest compartment and secured by the left lid), and whatever stores and spare parts for repairs each battery commander may consider necessary, for which there is ample space. There is a folding forage-rack at the rear of the wagon body, and a rail around the top for the lashing on of forage. A fixture on the middle rail in front of the anvil, in connection with the limbs and attachment bolt of the vise, which is permanently attached to the middle rail, secures, on top, the sledge, and underneath, between the flanges of angle-iron, a lunette prop for use when the wagon is unlimbered.

Road-brakes, one on each side of wagon, permanently attached to wagon axle and secured in the traveling position against the side of body by spring jaws, are provided. These are to be applied, necessarily, by a person on the ground by the side of the wagon, by a quick, strong jerk outwardly to free from the carrying jaws, and then by dropping the shoe over the tire of wheel. This may be done while the wagon is in motion.

To unlock the brakes and take them off the wheels, take hold of the handle of the locking-lever and press it towards the body of the wagon until its locking-latch is free, then raise the lever up to the position—nearly vertical—that frees the tang of the brake-eye; the stress lengthwise on the brake will elongate it, and the chain attached to the brake-shoe and the wagon-body will prevent the brake from being caught on and following the wheel, now free to revolve. A slight pull forward on the chain will free the brake-shoe from the wheel; the brake may then be pushed back on the eye-tang, the lever locked, and the brake returned to the traveling position.

FIELD BATTERY WAGON

Similar brakes are on the caisson. These, permanently attached at the eye-end to the axle-strap, are carried by a simple hook-latch around the top of forward chest-handles. Unhook them when required by turning the latches around the latch-pivots until free from the handles, then pass the shoe over the tire and drop the brake on the wheel to lock it. To remove the brake, proceed in a manner similar to that of removing the brake from the battery wagon-wheel above detailed. Or, if the cannoneer be mounted and it be simpler and more convenient for him, as follows:

When raising the locking-lever, as directed above, do not stop at the vertical position, but continue the movement to the rear, and by so doing—using the lever as a means, and applying the requisite force—raise up the brake from off the wheel until the shoe can be seized with the other hand and with it forced back on the eye-tang to the locking position. The lever can then be folded over and secured to the brake, and the brake fastened to the chest-handle in the traveling position.

The caisson brakes can be applied either by a cannoneer on the ground, as in the case of the battery wagon, or by one on the forward limber-chest; in either case while on the march without stopping to put the brake on or take it off the wheel.

On the caisson can be carried:

Two long-handled shovels	By suitable attachments underneath.
Two pickaxes	
One spare pole	
Two spades	Between the chests.
Two axes	
Four watering buckets (in "nests" of two each).	Bail of outer buckets around one or both "floor-rods," in rear of rear chest.
One or two lanterns	In the interior buckets.
Two paulins	On the chests.
One maneuvering handspike	Right side, along the side rail.
One section of picket-rope	Coiled around spare wheel-axle bolster, or around floor-rods and rear cross-bar.
One spare wheel	On spare wheel-axle.

Two extra boxes of projectiles also can be carried, one on each side of spare wheel-axle, resting on the "floor-rods," and lashed on.

On the caisson-limber, also gun-limber, can be carried:

Two paulins	On and strapped to chest-lid, ordinarily not carried on caisson-limbers.
Two spare obturators, or	In water-tight, cylindrical boxes under the chest. Ordinarily not carried on caisson-limbers.
Two or more (depending on size) boxes of primers, or	
One obturator and one or more boxes of primers.	
One oiler, one tool-box, and one wheel-grease can with spatula.	In compartment under the foot-boards. Wheel-grease can with spatula only ordinarily carried on caisson-limbers.
One pole-prop for end of pole	Under foot-boards, left-hand side, between chest and axle, and attached by catch-spring to one foot-board hinge.
One section of picket-rope (can be used for a prolonge), with metal terminals for connections with other sections.	On the foot-boards. One of these sections is carried for and with each carriage and ordinarily for gun-carriage and limber, coiled under the left seat of gun-carriage; for the battery wagon and forge, in the wagon, on top of it, fastened to railing, in the folding-forage rack, or coiled around the middle rail, near the vise, as may be most convenient; and for caisson on its limber foot-boards, or on caisson, as above detailed.

Three or four knapsacks, with canvas boot.	On foot-boards, under the boot, with which each chest is provided. All chests have the staples and buttons for attachment of boot. Ordinarily nothing but the boot is carried, folded up under the paulins or paulin-straps. Knapsacks are carried in the "artillery store-wagon."
One breech-sight	In place made for it in all gun-carriage and caisson limber-chests, ordinarily carried in the gun limber-chest. A spare one may be carried in one of the caisson-limbers.
Two haversacks	In middle chest compartment, on top of cartridges, ordinarily carried in the gun limber chest.

The tool-box (one for each gun, carried in compartment under the foot-boards of gun-limber) has capacity for the following tools and implements:

1 screw-wrench.
1 iron nut-wrench, 12 inches long.
1 ¾-inch cold-chisel, 8 inches long.
1 8-inch bastard file.
1 hand-hammer. 12¼-inch handle.
1 small steel punch.
1 vent-punch ....
1 gunner's gimlet ....
1 priming-wire ....
} These may be carried, if more convenient, in the gun-carriage trail-box.
Weight of tool-box, 1 pound 13 ounces.
Contents (as above), 7 pounds 8 ounces.

The carpenter's and wheelwrights's chest contains:

1 brace, with 12 assorted bits.
1 12-inch drawing-knife.
1 20-inch hand-saw.
1 26-inch rip-saw.
1 hand-ax.
1 claw-hammer.
4 framing-chisels (¾, 1, 1¼ and 2-inch).
3 framing-gouges (½, 1, and 1½-inch).
1 12-inch screw-wrench.
1 jack-plane.
1 smoothing-plane.
1 spoke-shave.
1 2-foot rule.
10 assorted brad-awls, with (and contained in) handle.
1 trying-square.
1 scribing-awl.
12 assorted saw-files (4 and 6-inch).
1 10-inch wood-rasp.
1 10-inch wood-file.
1 oiler.
1 8-inch oil-stone.
1 gauge.
1 10-inch compass.
1 table-vise.
1 pincers.
1 wood mallet.
6 auger-bits (¼, ½, ¾, 1, 1¼, and 1½-inch).
1 "patent" auger-handle.
3 file-handles, iron (4-inch flat, 4-inch round, and 5-inch).
1 Chesterman-Sheffield linen tape-line.
2 small canvass bags for small stores.
Weight of chest empty, 55 pounds.
Weight of contents, as above, 47 pounds 8 ounces.

The saddler's chest contains:

1 round knife.
1 shoe-knife.
1 draw-gauge.
6 assorted stitching-awls, handled.
1 rivet-set, 2 holes.
1 revolving-punch (4 tubes, Nos. 4, 5, 6, and 7).
1 claw-tool.
1 6-inch compass.
1 creaser, wood.
1 cutting-nippers.
1 riveting-hammer.
1 edge-tool, No. 2.
1 rule, 2-foot, wood.
1 oil-stone.
1 pliers, large.
1 driving-punch, No. 5.
1 stitching-horse complete.
2 small canvas bags for small stores.
Weight of chest empty, 50 pounds.
Weight of contents, as above, 29 pounds 6 ounces.

The forge chest contains:

1 portable "Empire" forge complete, modified for army use.
1 hand-hammer, handled.
1 riveting-hammer.
1 smith's tongs, 11-inch.
1 tongs for ½-inch iron.
1 tongs for ¼-inch iron.
1 chisel for hot iron, handled.
1 chisel for cold iron, handled.
1 fore-punch and creaser, handled.
1 hand cold-chisel.
1 12-inch flat bastard file.
1 round hand-punch.
1 hardy.
1 12-inch screw-wrench.
1 2-foot rule, wood.
1 square, steel.
1 oiler.
1 6-inch iron file-handle.
1 small wrench for portable forge.
1 fire-rake.
1 fire-shovel.
2 small canvas bags for nails and small stores.
2 smith's leather aprons.
1 sole-leather shoeing-box, and the following farrier's tools, viz:
1 shoeing-hammer.
1 pritchel.
1 16-inch shoeing-rasp.
2 shoeing-knives.
1 toe-knife.
1 shoeing-pincers.
1 clinching-iron.
1 nail-punch.
Weight of chest empty, 150 pounds 8 ounces.
Weight of contents (as above): Forge complete, 61 pounds 8 ounces; tools, etc., 39 pounds 8 ounces; total, 101 pounds.

The weight at the end of the pole, without neck-yoke of the gun-carriage and limber, with wheel-grease can, oiler, and tool-box filled with tools in compartment under the foot-boards, but without load or cannoneers:

For the heavy carriage, about 8½ pounds. For the light carriage, greater (not determined).

Only with knapsacks and cannoneers mounted would these weights be materially changed, for the center of limber-chest and center of axle are in the same vertical plane. With chest fully or partially filled, the weight may always be equally distributed in front and rear of axle. When partially filled, the weight may be lessened either in front or rear as desired.

The weight at the end of the caisson-pole, without neck-yoke, with the caisson fully loaded with ammunition, paulins, spare pole and wheel, intrenching tools, can in compartment under limber foot-boards, water-buckets, and lantern, about 6½ pounds.

Same without the spare wheel, about 16 pounds.

The weight at the end of the battery and forge-pole, without neck-yoke, fully equipped with tools, etc., but without stores, forage, and coal, is practically nothing—the weight in front of the limber (forge) axle about balancing the weight in rear—sufficient only to carry the pole down if raised up.

This condition makes it practicable always for such a distribution of load as to insure the desired weight at the end of the pole.

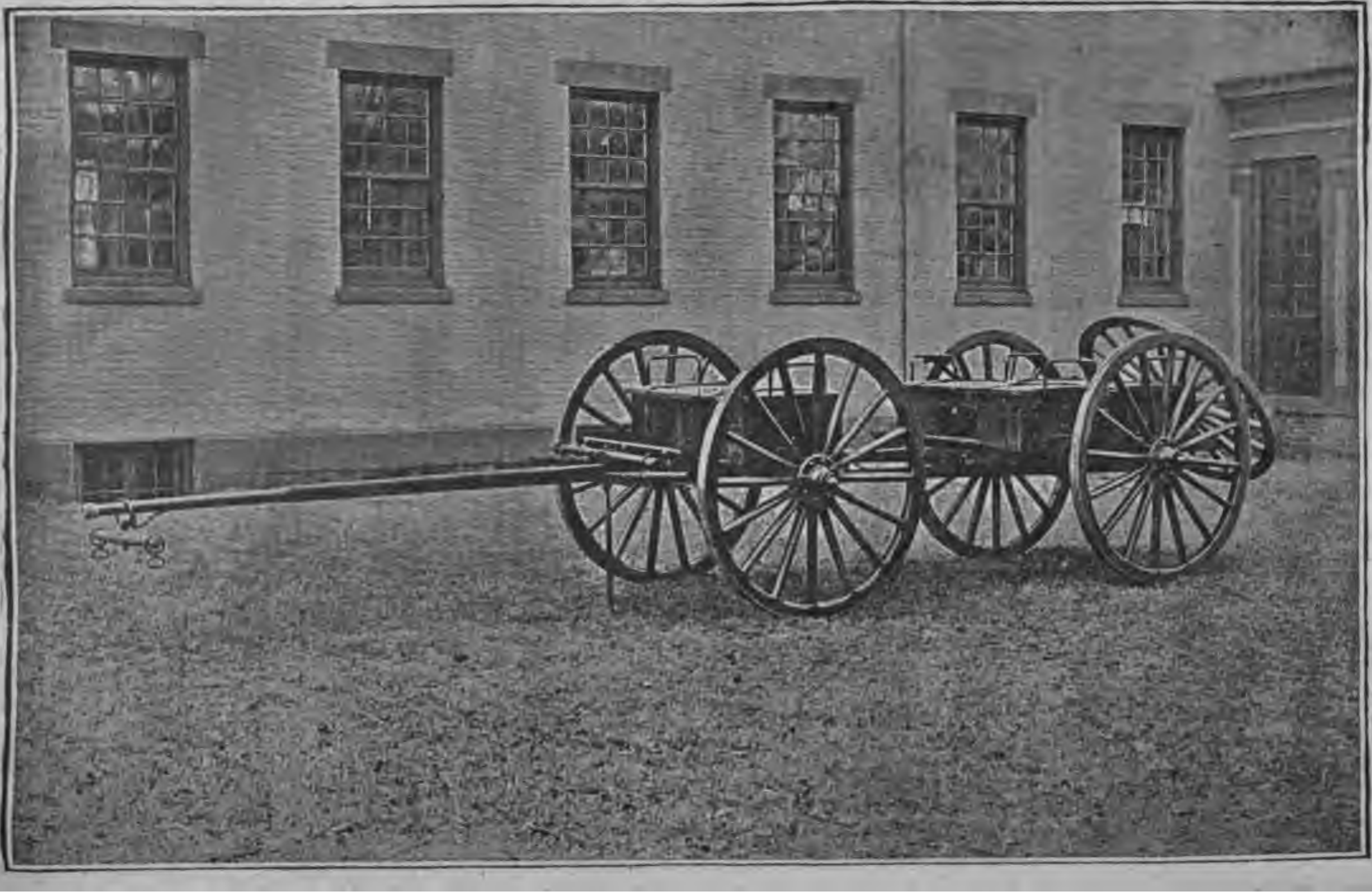
All chests are keyed on by bolt-keys, which are attached to chains connected on all limbers excepting the forge (battery-wagon limber) with the caps or lids of the obturator and primer-boxes, and on the caissons and forge, with permanent staples riveted to side bars and hounds.

The spare wheel axle is like the old one, but shorter and with but one link to the toggle.

The spare pole is carried immediately beneath the middle rail in a stirrup in rear and hook in front. This stirrup is suspended from a bolt around which it is free to revolve, so that when there is no pole in it it may swing out of the way of obstructions. The hook, on which is hung the neck-yoke stop at the end of the pole, is guarded by a safety-spring, which it is necessary to press up when putting up or taking off a pole. In the former operation this is accomplished in the act of hooking up the pole; in the latter the spring must be forced up with the hand before the pole can be unhooked; both operations may be done without stooping.

The long-handled shovels are carried beneath, midway between the middle and side rails, one on each side. The concave faces of the blades are towards and resting against the axle, under side, the shovel-points being passed into staple-straps in rear of the axle and the shovels handles, afterwards, into spring catches on the front cross-bar, against which the ends of handles rest. These catches are positive; the handle can be forced into them but not out of them without first bending down the catches—easily done with the hand that removes the handles, and without stooping.

The pick axes, which must be put on *before* the shovels, are carried beneath by fixtures attached to both middle and side rails. The ends of the handles are brought together, the *pointed* halves of the blades overlapped, one in advance of the other (if the spare pole be on, this must be done *above* the pole); handle ends are then passed into a broad strap of sheet-metal depending from the middle rail, and at the same time the outer blade ends into brackets or shelves on the side rails. In this position the overlapping blades should be under a spring-catch and immediately in front of a bracket or shelf on the middle rail, which is to support the picks, and to get them into which they should be pressed up against the spring and forward (towards the axle) until the spring falls behind them. This spring has, towards the axle, a long branch on which to place the hand when pressing up the spring to remove the picks.



The axes and spades are carried between the chests. A board is there, permanently riveted to the side rails at each end. Within the rails on opposite sides are slots of the length and form of the ax-blade into which the blades are placed vertically, the helves resting on top of the board. The spade blades—spade-handles crossed—are placed on the board, one at each side, between the helve of one and blade of the other ax, concave, face toward the ax-blade, the ends of spade-blades against the outer branch of the upright metal stops fastened to the board-ends; the handles of the spades are then forced down until the ends rest on top of the axes. In this position they retain the axes in place, and, being under the *overlap* of chest-lids and prevented by the stops from moving sidewise, they can not be shaken out on the march.

The water-buckets, made in pairs, one fitting in the other "nest" fashion, the bail of outer bucket made in two parts formed into an eye and spring-hook for connection in the center, can be carried on any part, permitting the bail to be passed around it and hooked. In the rear the cross-bar and floor-rods offer secure and suitable places. In the buckets the lanterns can be carried securely, one in each nest, with a little hay packing. The picket-rope section can be carried on the various carriages as above indicated. The maneuvering handspike is carried along the right-side rail outside. A bronze socket for the large end is secured to the right axle "coached bed," and under the foot-board are spring jaws for the small end. A bronze ring on the handspike, when in position, falls immediately in rear of the jaws and prevents any forward motion. Put the large end first into the socket, then force the small end into the jaws. To remove the handspike pull it from the jaws, taking hold of it in front of them. The canvas boot to cover knapsacks on the foot-boards has slits for the paulin-straps to pass through; has eyes and straps to pass over and through the staples on the chest-lids, and button-holes for the buttons on the ends of chests. The side ends of the boot are buttoned over these latter after the knapsacks are adjusted on the foot-boards and "tucked under" with the boot in front.

To remove a brake either from the caisson or battery wagon remove the bolt of the axle-strap by unscrewing the bolt-nut and pulling out the bolt; the strap to which the brake is permanently eyed can then be taken off with the brake.

The weights of the parts of the carriages vary, depending on the character of the wood and varying dimensions of the metal. The poles vary from 22.5 pounds as a minimum for ash to 30.5 pounds as a maximum for oak. The chests vary from 168.5 to 175 pounds. The neck-yokes, double and single trees, vary a pound or so, more or less. The angles used for the metal bodies are not always uniform in thickness, resulting in variations of weight of these parts. The wheels vary from 196 pounds to 201.75, averaging about 200—the average of six wheels weighed was 199$\frac{3}{4}$ pounds.

The following weights have been made up from the model carriages, equipments, etc.:

3.20-inch gun, gun-carriage, limber, weights, and equipments.

No.	Article.	Weight.		Total.	
		Lbs.	*Ozs.*	*Lbs.*	*Ozs.*
1	3.20-inch B. L. rifle			829	
1	Carriage, with brakes { heavy			1,300	
	Carriage, with brakes { light			(1,166)	
1	Jointed sponge and rammer, with sponge cover	7			
2	Short rammers and sponges combined, and covers	7	14		
1	Prolonge (section picket-rope)	15	8		
2	Primer-pouches	1			
2	Lanyards		8		
				31	14
1	Limber, complete with neck-yoke			957	4
1	Wheel-grease can and spatula	5	8		
1	Breech-sight	2	2		
1	Breech-sight pouch		9		
1	Sperm oiler		7		
1	Tool-box, with tools	9	2		
1	Pole-prop	2	8		
2	Paulins 11 by 11 feet	46			
1	Knapsack-boot	3	8		
2	Gunners' haversacks	4	6		
				74	2
42	Projectiles, shell and shrapnel, 13.5 pounds each	567			
44	Cartridges, each 3¾ pounds	165			
44	Cartridge-bags	2	12		
				734	12
	Total { for heavy carriage			3,927	0
	Total { for light carriage			3,793	0
	Weight per horse with heavy carriage			654.5	
	Weight per horse with light carriage			632	

Caisson, weights, and equipment.

No.	Article.	Weights.		Total.	
		Lbs.	*Ozs.*	*Lbs.*	*Oz.*
1	Caisson, complete, with brakes and neck-yoke			2,216	8
2	Axes, handled	10			
2	Pickaxes, handled	15			
2	Shovels, long-handled	8			
2	Spades, short-handled	10			
2	Paulins	46			
4	Water-buckets (2 nests)	15			
1	Lantern	1	8		
1	Prolonge (picket-rope section)	15	8		
1	Pole-prop	2	8		
1	Grease-can and spatula	5	8		
1	Knapsack-boot	3	8		
				132	8
126	Projectiles, shell and shrapnel, 13.5 pounds each	1,701			
132	Cartridges, 3¾ pounds each	495			
132	Cartridge-bags	8	4	2,204	4
	Total weight			4,553	4

	Pounds.
Weight per horse, with above equipment	759
Weight per horse, with above equipment and spare wheel	792
Weight per horse, with above equipment and spare pole	763+
Weight per horse, with above equipment and spare handspike	759+
Weight of caisson with spare wheel	4,758
Weight of caisson with spare pole	4,581
Weight of caisson with spare handspike	4,558.75

Forge and battery wagon, weights and equipment.

No.	Article.	Weights.		Total.	
		Lbs.	*Ozs.*	*Lbs.*	*Ozs.*
1	Forge and battery wagon, complete, with brakes and neck-yoke, but without stores	......	......	2,081	......
1	Set blacksmith's and farrier's tools complete	39	8	......	......
1	Coal-bag	4	8	......	......
1	Forge, complete	61	8	......	......
1	Tool-chest, wheelwright's, complete	55	......	......	......
1	Set tools, wheelwright's, complete	47	8	......	......
1	Tool-chest, saddler's, complete	50	......	......	......
1	Set tools, saddler's, complete	29	8	......	......
1	Pole-prop	2	8	......	......
1	Vise	32	......	......	......
1	Hammer-sledge	10	8	......	......
1	Anvil	100	......	......	......
1	Battery wagon lunette-prop	5	......	......	......
1	Grindstone, flanges, shaft, and crank complete	50	8	......	......
1	Grindstone frame, complete	18	......	......	......
1	Can for coal-oil	7	8	......	......
1	Can for sperm-oil	1	......	......	......
1	Grease can and spatula	5	8	......	......
1	Lantern	1	8	......	......
2	Water-buckets	7	8	......	......
2	Paulins	46	......	......	......
1	Prolonge (picket-rope section)	15	8	......	......
				590	8
	Total weight	......	......	2,671	8
	Weight per horse, without stores	......	......	445	......

A short sponge, a short rammer, and a long combined sponge and rammer, were at first provided for the service of the 3.2-inch field gun, and provisions made on the carriage to carry—the first two between the cheeks under the gun, and the last on the left side against the flask, held by a toggle, the staff being hinged near the center and folded, the link of toggle passing between the parts and the button turned at a right angle over them. To meet the wants of the tactics afterward prepared for the gun, the short rammer and sponge have also been combined into one and hooks placed upon the staff, so that after use, before firing, instead of returning the sponge and rammer to the carrying position between the cheeks, it can be attached quickly to a seat guard-rail, to remain until again needed after firing. These are heavy cast-bronze hooks, the one next to the sponge-head being fast, immovable, on the staff, the other movable and actuated by a spring. This latter hook, hooked from the inside, around the seat guard-rail just above the latch standard—cannoneer being in rear of axle enables the user, by pulling on the rammer-head with both hands, to swing the other hook around behind the forward upright part of rail, and then to secure it by allowing the spring to carry the implement forward. To remove it again it is only necessary to pull to the rear upon the rammer-head and swing the staff toward the gun until the forward hook be free from the seat-rail. These hooks have been so placed on the staff as to require no change in the attachments between the cheeks where the short sponge and rammer is to be habitually carried.

Two (one spare) short rammers and sponges will be carried with each gun. No change has been made in the long sponge and rammer, except to put metal ferrules around the staff as a safe for the toggle-button. This has been found necessary to protect the staff, and should not be omitted in manufacture.

The new harness is a great improvement on the old—relieving the horses of much hard work, being better adapted for the kind of work required, and permitting a degree of celerity in hitching up, unhitching, and replacing horses unattainable with the old. The neck-yoke makes the carriage sensitive to any lateral movements of the wheel-horses and consequently places it completely under the control of the driver. The double and single-trees insure the proper distribution between the horses of the draft, and, in connection with the spring-tugs on the traces, that elasticity and absence of rigidity—a marked feature of the old system—so essential for the welfare of the horse. There is a difference of but one ounce in favor of the old harness, as follows:

NEW.

	lbs.	ozs.				
Weight of wheel-set for two horses	75	3				
	72	6	147	9		
Weight of lead-set for two horses	65	14				
	66	8	132	6		
Total weight of wheel and lead-sets					279	15

OLD.

Weight of wheel-set for two horses	78	5				
	72	9	150	14		
Weight of lead-set for two horses	65	12				
	63	4	129	00		
Total weight of wheel and lead-sets					279	14
Difference						1

The weights in detail and nomenclature are given in the appended table. The saddle in this table, it appears probable now, will be, excepting the color, made exactly like the cavalry saddle, and thus have but one saddle for the service.

There are good reasons why this should be done aside from considerations of simplicity and economy for the service, but this alone should be sufficient, and would be in keeping with much that has been accomplished in the new constructions.

The combined collar and hames of the new harness may be improved and lessened in weight by the use of a steel collar. Steel collars have been used in this and other countries by city fire departments, but the kind referred to is a recent improvement.

It may be interesting and instructive to compare the new constructions with the old and with foreign carriages in the matter of mobility and efficiency when equipped for the field. The information in regard to foreign carriages, equipments, etc., is conflicting, and even in the same statement, in one or more cases, there are discrepancies difficult to reconcile.

The appended table has been made up from various foreign and native statements,* and must be taken as a combination of them all with such econciling corrections as appeared to be justly derived from the data iven, and reasonable from the connections. An examination of this able shows that, although in two cases, viz, the 7-c. (2.95-inch) Italian nd the United States 3-inch M. L. guns—with the gun-team only of he former—the number of pounds of transportation per projectile is less han for the United States 3.2-inch, the pounds of transportation per ound of projectile is less for the United States 3.2-inch gun than for ny other, foreign or native, not excepting the old 6-pounder, which for he gun-team was 7.01 pounds and for the caisson 1.96 pounds. In the wo cases where the transportation per projectile is less, it will be seen hat the guns bear no comparison with the United States 3.2-inch, the harges being but 1.87 and 1 pound, and the projectile (shrapnels) 10.5 ounds each, the Italian gun having but four horses to a team.

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* U. S. Army Artillery Tactics, 1874. Ordnance Notes, No.350. "Public Service Review for September, 1887." Reglement sur le service de canons de campagne. Memorial de Artilleria, Mar., 1888. Revista de Artiglieria e Genio. Proceedings Royal Artillery Institution, July, 1888. Aide memoire de campagne, Paris, 1883. Hand-book for Field Service, London, 1884, etc., etc.

The old U. S. 3-inch M. L. gun was provided with 50 rounds per hest. In the artillery tactics of 1874 it is prescribed that 60 and 72 ounds, according to the divisions of the ammunition chest, shall be arried, but this was a prescription only—it never had any existence in ractice. But, taking the matter either way—in the appended table he first or actual provision is given—the result still gives more pounds f transportation per pound of projectile for the caisson team, carrying 2 rounds per chest, than for the 3.2-inch gun, the gun-team, however, eing 0.57 pound less. To be able in the first instant to oppose to an nemy a greater number of rounds per gun with a less amount of transortation per pound of projectile, and at the same time not have the oad per horse above the reasonable limit pretty well established by ractice and confirmed by the experience of war, must be taken, other hings being equal, as a just measure of efficiency, and is not indicative f falling short of the product of a past generation, particularly when onsidered in the light of the more complex nature of, and greater trength required in, the constructions of to-day.

As to "other things being equal," the ballistic properties of the guns, s shown limitedly in the table, will determine. With an initial velocity ,670 f.-s. (a powder which gave 1,750 f.-s. for this gun, with a shell of 3 pounds, the powder-makers have not been able to reproduce) and a rojectile of 13.5 pounds, the 3.2-inch gun would not be placed at the oot of the list, or, indeed, in the middle, by any one qualified to deterine its position as to merit.

The attainment of high velocity has been the motive in the construcion of this gun and its carriage, and in securing it American ordnance fficers have but kept pace with the lessons of the time.

Good authority says artillery must "always go in as close as possible o the enemy," depending on the stage of battle, from 4,000 to 1,200 ards, and even into the line of skirmishers. The nearer the target the ore effective becomes the high velocity by increasing the depth of the angerous zone, and consequently the probability of hitting.

"The artillery must in the first place hit, in the second place hit, and n the third place hit." (Prince Hohenlohe's correspondent "Letters n Artillery," p. 385.)

"A high velocity increases the probability of hitting, and therefore t would seem that velocity is of greater importance than the size of the hell after the latter has reached a certain limit. This is essentially so ith shrapnel-shell, because the depth of the dangerous zone depends n the flatness of the trajectory. It may be objected that high velociies increase the difficulty of bursting shrapnel properly, but even if the ccuracy is impaired, which can not be entirely admitted with our latest uses (they can be set with certainty to eighths of a second), it is not necessary with deep zones of action; in fact, I say the probability of hitting is increased, and that kind of accuracy is more desirable in war than mathematically correct practice. * * * The power of a shell can only be measured by its effect. Experience tends to prove that the effect of shrapnel varies inversely as the angle of fall (*i. e.*, *cœteris paribus*, directly as the velocity) and directly as the weight of its contents of balls." (R. F. Johnson, Capt., R. A.; reprint from Colburn's U. S. Magazine in "The United Service," June, 1889.) Captain Johnson states that the weights behind horse-artillery teams (of six horses) in France and Germany are 37 cwt. 3 qrs. 23 lbs. (4,251 pounds), and 35 cwt. 1 qr. 23 lbs. (3,971 pounds), respectively; and field mounted artillery teams, 46 cwt. 3 qrs. 12 lbs. (5,248 pounds), and 46 cwt. 2 qrs. 20 lbs. (5,228 pounds), respectively, for horses inferior to English horses. "A gun giving about 40 cwt. (4,480 pounds) for horse-artillery equipment, and 45 cwt. (5,040 pounds) with extra gunners of field batteries, appears quite admissible, though it should not be exceeded."

With the 3.2-inch gun equipment, spare wheels, spare poles, and maneuvering handspikes are not considered as part of the regular caisson equipment.

In war time it is proposed to carry on each spare caisson a spare wheel, on the left caisson of each platoon a spare pole, and on the right caisson of each platoon a spare handspike.

In horse artillery the front chest of each caisson body should be removed to bring the caisson and gun-team loads to an equality and give space for forage. This will reduce the weight to 3,643.5 pounds.

Weight per horse (horse-artillery caisson)	607.21 pounds.	
Weight per horse (caisson with regular equipment)	758.87 pounds,	without cannoneers.
Weight per horse (caisson with spare handspike)	759.79 pounds,	
Weight per horse (caisson with spare pole)	763.62 pounds,	
Weight per horse (caisson with spare wheel)	792.20 pounds,	
Weight per horse (gun-team)	632. pounds,	

Comparing these figures with the foreign for horse artillery 607 and 632 (gun and caisson-teams) per horse, stand against 708 (France), 661 (Germany), 746 (Captain Johnson as above) per horse.

For field mounted artillery, with five cannoneers mounted on the gun-carriage and limber of 160 pounds each, 765 for gun-team stand against 784 (France), 871 (Germany), 840 (Captain Johnson as above). For caisson team against these same figures stand 758, to 792 as given above, without cannoneers. The margin here is small for cannoneers, but it will always be within the power of the battery commander to reduce the amount of ammunition carried in accordance with the mobility required, for 231 (see below) rounds per gun (war footing) is largely in excess (120 rounds is sufficient) of what is regarded as necessary, and may be safely reduced when required. Ten rounds less in a caisson-chest would reduce the caisson load over 86 pounds per horse and still leave 138 rounds per gun without extra caissons. It is better to have, than to be without, a large capacity for carrying ammunition. It is preferable and safer to have it and not carry the ammunition, than to be without the capacity for an urgent occasion, particularly when it costs but little in the way of additional weight.

3.2-INCH FIELD ARTILLERY EQUIPMENT.

NUMBER OF PROJECTILES CARRIED WHEN ON A WAR FOOTING.

Mounted battery.

	Rounds.
In the 6 gun-limbers, 6 chests, 6 by 42	252
In the 6 caissons, 18 chests, 18 by 42	756
In the 3 spare caissons, 9 chests, 9 by 42	378
Total per battery	1,386

Number of rounds per gun, 231.

If two packing-boxes (10 rounds each) are carried into battle by each gun-caisson, the total amount of ammunition will be increased—12 boxes by 10 rounds	120
Total per battery	1,506

Number of rounds per gun, 251.

Horse battery.

	Rounds.
In the 6 gun-limbers, 6 chests, 6 by 42	252
In the 6 caissons, 12 chests, 12 by 42	504
In the 3 spare caissons, 6 chests, 6 by 42	252
Total per battery	1,008

Number of rounds per gun, 168.

Before leaving the subject of mobility the practical lessons of the field should be considered. The following is a statement by Col. E. B. Williston of his experience in the civil war with light 12-pounder guns in mounted and horse batteries.

The details of ammunition, weights, etc., for the light 12 pounder bronze gun, model 1857, will be found in the appended table:

On each gun-carriage were carried—
  Two sponges and rammers.
  Two handspikes.
  One sponge-bucket.
On each limber—
  One paulin, 12 by 15 feet.
  Two axes.
  Two water-buckets.
  One lantern.
  Four knapsacks.
  One grease bucket.
On each caisson—
  Two paulins, 12 by 15 feet.
  One spare pole.
  One spare wheel.
  Two axes.
  Two spades.
  Two long-handled shovels.
  One pick-axe, handled.
  One mattock, handled.
  Eight knapsacks.
  Forage, when necessary, and two pieces of picket-rope 2 inches diameter, each 275 feet long, were carried sometimes on the caissons (generally carried on the battery wagon).

When equipped as a horse battery no knapsacks were carried on the carriages, but on each foot-board was secured a box holding two oil-lanterns, one half-quart can of oil, six horse-shoes (fitted), twenty-four horse-shoe nails.

General McClellan, when he organized the Army of the Potomac in 1861, ordered that half the batteries should be armed with light 12-pounders. General Hunt, Chief of Artillery, reported: "This gun held its own to the end of the war." General McClellan's order did not apply to the horse batteries, which were armed with 3-inch muzzle-loading rifles up to July, 1863.

The mobility of these light 12-pounder batteries was never questioned. They accompanied the infantry commands to which they were attached at all times, often over extremely bad roads and rough, hilly country. Probably they all had about the same experience, and a few instances, given from the experience of one, will fairly illustrate the difficulties encountered by the others during the war.

Light Battery D, Second U. S. Artillery, was attached to the Sixth Army Corps from the date of its organization to July, 1863—before that date to Franklin's Division. During Burnside's "mud march" the battery, being at United States Ford, was ordered to proceed to its old camp. The mud being very deep, an infantry regiment was ordered to report to the battery commander to assist in pulling the guns; this assistance was declined, and the battery, without help from outside, made the march of 21 miles in less than ten hours, no team being doubled. The mud was so deep that the naves of the wheels were frequently buried therein and remained so covered for quite a distance at a time. The cannoneers were at times so stuck in the mud that they had to be pulled out—one man fell in front of one of the guns, which passed over him, pressing his body into the soft mud almost out of sight, but not inflicting any serious injury; he continued to perform his duty. In pulling through this deep mud some wheel-traces were broken, but nothing else.

The regiment before mentioned did not reach its camp near that of the battery until late the next afternoon, having been occupied simply in getting back to its camp.

This same battery, after a rapid march from Fredericksburgh in 1863, made a forced march to Gettysburgh on July 2, as follows: Starting from a point 38 miles from the battle-field at 2 o'clock a. m., it moved along a trail or cow-path until the path was lost in a narrow ravine with high, precipitous sides, in which it was necessary to completely dismount the carriages and reverse them by hand, leading the teams, unhitched, over the carriages as they lay on the ground. Notwithstanding this delay, and the fact that the roads were reserved for the infantry (the artillery getting along as best it might in the fields until when within 10 miles of Gettysburgh it got ahead of the infantry and took the road), the battery was reported for duty and put in action before 2 o'clock p. m., having marched at least 42 miles. Changes of position made during the afternoon increased this distance to at least 45 miles. At night the teams were in good condition, except that the horses were very tired. The harness was not removed during the night. The battery was moved to several positions on the 4th, and without rest accompanied the corps on the 5th, it forming the infantry advance in pursuit of the Confederate army, which only ceased when the Potomac River was reached. This march from Fredericksburgh to the Potomac via Gettysburgh was very hard, and made in hot weather, on less than the proper allowance of forage, and that mostly grain. At times the horses really suffered from the lack of water. When the Potomac was reached the horses were in good condition.

During the Chancellorsville campaign the battery, after having been harnessed and hitched for seven days (two days engaged in action), made a march of about 30 miles on the eighth day, in the rain and over muddy roads and fields, the teams remaining in good condition.

During these movements oats or corn was (when obtainable) carried on the caissons, generally five sacks to a caisson, weighing between 500 and 600 pounds.

The cannoneers were frequently carried for long distances.

Preceding the battle of Gettysburgh General John Buford, commanding the First Cavalry Division, had severe fighting near that place with the Confederate infantry.

General Buford's horse batteries were armed with 3-inch guns, which, in his opinion, did not develop the power and effect, or superiority at close range, required, consequently he requested, immediately after the battle, that he be provided with a horse battery armed with light 12-pounders. This request being approved, General Hunt designated battery D, Second U. S. Artillery, to be the one to be so equipped. The order was received on July 15, and the battery, then on the march at Boonsborough, pushed on without stopping to near Berlin, a march of 48 miles. This was the first battery to be thus equipped, and General Hunt had some doubts as to its mobility, consequently he ordered that each carriage should have eight horses.

During the drilling that was necessary for instruction it became evident that the team of eight horses was too long and cumbersome, and the battery commander reduced it to six, subject to approval after satisfactory trials.

Early in September, 1863, General Buford notified General Hunt that he was going to attack the Confederate cavalry near Culpeper, and invited him to accompany the command and watch the movements of this new battery, which he did. After quite a march the enemy was found, engaged, routed, and driven across the river. The battery was engaged all day, and marched at least 35 miles. Both generals expressed themselves as highly pleased with the battery, and satisfied that six-horse teams provided for all required mobility. The extra horses were turned in, and six horses were used by this battery, and others equipped like it, during the rest of the war.

General Hunt was not only convinced that six horses to a carriage were sufficient, but was so impressed with the mobility and efficiency of the battery that he approved of General Buford's recommendation that other batteries be thus armed and ordered for duty with the cavalry.

General Hunt reported, "at the request of General Buford several of these batteries (light 12-pounders) were equipped as horse artillery because of their superiority at close range—with six horses to a piece they answered the purpose." Among the batteries mentioned were Butler's Second Artillery, Randall's First Artillery, and King's Fourth Artillery. These batteries had six guns, six caissons, one forge, and one battery wagon, all drawn by six horses except the last, which had eight.

During their service with the cavalry these batteries always kept up on the march, and their mobility was conceded.

A great deal of this service was performed under difficulties, such as night marching over hilly and rough country, over mountain roads and passes, along wood roads, paths, and trails across country, having no roads to follow—in snow, rain, and mud. The horses were often kept harnessed and hitched for days together; were on half forage or less, and often separated from the forge, etc.

In 1864 General Hunt reorganized the horse artillery, reducing the number of batteries and guns; each battery had four guns, two light 12-pounders, and two 3-inch guns.

To illustrate the mobility of these light 12-pounder horse batteries, the Sheridan raid of 1864, from the Army of the Potomac to White House, may be referred to. This was previous to the reorganization above mentioned, and the batteries had but one kind of guns—that is, either light 12-pounders or 3-inch.

My battery (D, Second Artillery), with six light 12-pounders, left a point near Fredericksburgh, Va., about 9 p. m. and reached Beaver Dam Station before daylight, a distance of not less than 35 miles. Five sacks of forage were carried on each caisson and an average of 25 pounds on all off-horses. The marching and fighting was continuous until we reached Haxhall's Landing. My horses were not unharnessed (except to groom them, if circumstances permitted) for two weeks. We foraged on the enemy's country during the most of that time. At the end of the raid the teams were in fair condition, and after resting one day the command pushed on. This occurred in May, and was followed by another raid from Petersburgh to near Gordonsville, in the early part of June, which was fully as severe on the horses. At no time during my service with the cavalry, when inside the enemy's lines, did I have occasion to borrow forage, although I loaned it to 3-inch batteries on several occasions.

Several times, when separated from my caissons and spare horses, and having lost horses in action, I was forced to use but four horses to a gun, and that number proved to be sufficient to move at ordinary gaits over average roads.

This experience with a gun of 645 pounds per horse for gun-team and 635 pounds for caisson, without cannoneers and without the extra weights mentioned in the above statement, in the actual campaign, is more instructive than any amount of even fine theory.

The roads traveled over could hardly be worse in this or any country where they are at all practicable for four-wheeled vehicles. In the light of this experience it can hardly be questioned that the 3.2-inch gun equipment, horse or mounted, has a mobility equal to any demand on it.

Alterations on the 3.2-inch gun have changed the weight from 791 to 829 pounds. Twenty-five, the first lot made for the service, weigh about 800 pounds each; of the second lot 10 weigh about 813, and 15 about 829 pounds, which, it is presumed, will remain the standard weight.

The shells as first designed weighed 13 pounds, shrapnel 13.5, but the shell has now been increased to 13.5—the charge for both being 3¾ pounds.

The first 25 carriages made have the double-screw elevating device, and weigh with the brakes about 1,300 pounds. The next lot of 25 have the "lazy-tongs" device, and weigh with the brakes about the same. These 50 are called the heavy carriages; no more of them will be made, and it is presumed the first lot will be converted (requiring removal of upper front transom only) into carriages for the 3.6-inch gun, which has been given the shape and dimensions about the trunnions to adapt it to the carriage, thus making the carriages of the two field-guns interchangeable, should necessity require it, on the battle-field. But little elevation can be obtained with the 3.6-inch gun on the 3.2-inch carriage, but enough to fight with in an emergency, and with a cold-chisel and hammer the latter can be converted for the former in the field. The carriages with the lazy-tongs elevating device are not so suitable for the 3.6-inch gun at high elevations; there is not room to operate the device, but the double screw could be substituted and the carriages converted. The light carriage is presumed to be strong enough for the heavy gun, which will be about 331 pounds heavier than the light gun—that is, for such a limited amount of firing as would be required in an emergency requiring the use of the heavy gun on the light carriage, and it may be strong enough for the heavy gun's permanent service. Should this be proved by test there need be no more heavy carriages constructed.

The 57-inch wheel insures an easy draught, and the stress on the pintle and double-tree bolt being in about the same plane, there is little or no tendency of the draught to increase or diminish the weight at the end of the pole. The pintle being in rear of the chest insures rapidity and ease in limbering up, and a turning angle of 60° facility of reversing in a limited space. The distance from the muzzle of piece, limbered up, to the end of the pole is 26 feet 6 inches, the distance between the centers of the axles being about 8 feet 9 inches. From the end of the pole to the end of the spare wheel axle of the caisson, limbered up, the distance is about 24 feet 6 inches, the distance between centers of axles being about 8 feet. With the spare wheel on the caisson and the folding rack at the back of the battery wagon down, the three carriages—gun-carriage and limber, caisson and limber, and battery wagon and forge—will occupy about the same distance in column, and the three together about the same distance as corresponding carriages for the light 12-pounder bronze gun.

The bow-spring brake, tested with the light carriage, is a great improvement over the spiral spring, and performs the work required perfectly. Having no initial tension it never left the wheel during the test of 500 service charges, and not bringing up against a rigid shoulder, it possesses elastic resistance to limit the extension of the brake. Being entirely automatic, requiring no time for manipulation in action, compact, out of the way of the gunners in the service of the piece, and available for a road-brake, it forms an important and valuable part of the gun-carriage.

The lazy-tongs elevating-screw projects, when run fully down, but little below the carriage, thus permitting it, when limbered up, to pass over obstacles between the wheels nearly as high as the axle. The other carriages can do the same, their equipment attachments being constructed with that end in view.

When all other requirements are satisfied, good looks should not be neglected. The men of a battery, it is believed, will fight better with a good-looking outfit than with a bad-looking one, other things being equal. This was not lost sight of during the construction. All the carriages are simple, neat-looking, and well proportioned, and when fully equipped present a trim appearance, in keeping with what they were made for.

A. R. BUFFINGTON,
Colonel, Ordnance Department, U. S. Army.

Comparative Table of Field and

Caliber of guns and model.	Germany.		France.		Austria.	
	8-c., 3.1-inch, model 1873.	9-c., 3.47-inch model 1873.	8-c., 3.15 inch, model 1877.	9-c., 3.54 inch. model 1877.	7-c., 2.95-inch, model 1875.	9-c., 3.43-inch, model 1875.
Total weight of gun, including breech mechanism ....lbs	858	990	946	1,166	658	1,071
Weight of carriage with gun.......lbs.	1,894	2,059	2,096	2,655	1,681	2,256
Number of ammunition-boxes on carriage	1	1	2	2	....	....
Weight of limber equipped, without ammunition ....lbs.	1,440.3	1,435.3	841.86	1,193.64	1,247.4	1,318.3
Total weight drawn by horses, without men or ammunition ....lbs.	3,413	3,611.3	3,048.9	3,875.6	2,941.4	3,606.3
Weight of ammunition ....lbs.	555	665.7	467.14	555.36	479.6	615.7
Total weight drawn by horses, with ammunition but without men ....lbs.	3,968	4,277	3,516	4,431	3,421	4,222
Total weight of fully-equipped caisson, without ammunition, rations, forage, or men...............................lbs.	2,806.1	3,272.28	2,665.27	3,379.74	2,881.4	3,000
Weight of ammunition .... lbs.	1,243.9	1,382.72	1,382.73	1,660.26	1,406.6	1,783
Total weight of caisson, as before, with ammunition ....lbs.	4,140	4,655	4,048	5,049	4,288	4,783
Number of projectiles for each gun ..	154	136	161	141	152	128
Weight of shell loaded and fused ..lbs	11.2	15.44	12.33	17.5	9.5	14
Weight of shrapnel loaded and fused lbs.	12	17.5	12.64	18	10.5	15.75
Weight of canister ....lbs	11	16.5	12.8	17.4	10.4	16.5
Weight of the firing charge ....lbs	2.75	3.3	3.3	4.18	2.1	2.3
Number of projectiles carried on gun and limber	39	33	31	27	40	34
Number of cartridges carried on gun and limber	43	36	34	29	40	34
Number of projectiles carried on caisson.	86	77	87	76	112	94
Number of cartridges carried on caisson	90	85	90	77	150	128
Pounds of carriage, limber, gun, and equipment for each projectile carried, gun team.	87.17	113.91	95.64	142.39	73.36	106.45
Pounds of same for each pound of projectile	6.14	5.42	6 52	6.97	6.13	5.85
Pounds of caisson and equipment for each projectile carried, caisson team..	33.67	42.49	30.17	44.47	25.72	31.91
Pounds of same for pound of projectile.	2.32	2.36	1.92	2.62	2.04	1.68
Initial velocity ....foot-seconds.	1,325	1,456	1,607	1,492	1,386	1,469
Ranges ....yds	6,196	6,551	7,655	7,535	5,000	5,000
For elevations of.......................	25°	25°	25°	25°	17°10′	15°12′
Number horses to a team, gun and caisson	6	6	6	6	6	6
Composition of a battery. { guns.......	6	6	6	6	8	8
Composition of a battery. { caissons ...	8	8	9	9	8	8
Weight per horse, gun team........lbs.	661	712	586	738	570	703
Weight per horse, caisson team.....lbs.	690	775	675	841	715	797

Horse Battery Guns and Equipment.

Italy.		England.	United States.			Russia.		
7-c., 2.95-inch, model 1874.	9-c., 3.43-inch, model 1876.	3-inch 12-pdr., B. L., 1888. (!)	3-inch M.L., model 1861.	3.2-inch B. L., model 1889.	4.62-inch S.B.M.L. 12-pdr., bronze, 1857.	Light 3.43-inch 4 pdr., model 1877.	Heavy 3.43-inch 4-pdr., model 1877.	4.21-inch 9-pdr., model 1877.
656	1,082	784	830	829	1,230	800	1,000	1,377
1,527	2,385	(*)	1,760	1,995	2,358	1,837	2,129	2,677
2	2	2 (!)	....	....	....	2	2	1
826.06	1,222.1	(*)	983.16	1,031.37	990.44	1,407.99	1,433.01	1,476.27
2,371.96	3,694.1	3,405.6	2,860	3,058.25	3,382	3,303.89	3,798	4,153.27
449.94	581.9	626.4	572.9	734.75	490	363.11	545	565.73
2,821.9	4,276	4,032	3,432.9	3,793.0	3,872	3,667	4,343	4,719
1,915.76	3,468.07	3,140.6	2,362	2,349	2,345	3,085.64	3,085.51	3,021.81
1,120.24	1,217.93	1,087.4	1,718.7	2,204.25	1,470	1,635.36	1,635.49	1,699.19
3,036	4,686	4,228	4,080.7	4,553.25	3,815	4,721	4,721	4,721
142	130	110	200	231	128	157	167	127
9.35	14.8	12.5	7.5	13.5	9.52	15.13	15.13	27.5
9.25	14.74	12.5	10.5	13.5	12.17	15.22	15.22	27.47
9	15.6	12.35	10	....	14.80	15	15	27
1.87	3.19	4.0	1	3.75	2.5	3	3	4
42	34	36	50	42	32	22	32	19
44	36	36	50	44	32	22	32	19
100	96	72	150	126	96	90	90	54
102	102	72	150	132	96	90	90	54
54.45	104.97	94.60	57.20	72.81	105.68	150.17	118.68	214.43
5.27	6.34	5.43	4.99	4.16	6.90	9.00	6.96	7.36
19.15	36.12	43.61	15.73	16.97	24.42	34.28	34.28	55.95
1.71	2.84	2.88	1.37	1.06	1.59	1.88	1.88	1.77
1,381	1,489	1,720	1,232	1,668	1,495	1,350	1,450	1,550
3,543	3,590	7,930	3,972	6,479	1,992	7,000	7,000	....
10°	10°	25°	20°	20°	10°	25°16′	22°5′	....
4	6	6	6	6	6	6	6	6
8	8	6	6	6	6	6	8	8
8	8	6	6	9	6	9	12	16
705	712	672	572	632	645	611	723	786
759	781	704	690	759	635	787†	786	786

* Weight of gun-carriage and limber, 2,482 pounds.

† Weight per horse for mounted battery. For horse battery 607 pounds per horse.

Comparative Table of the Old and New Harness.

No.		New.								Old.							
		Wheel.				Lead.				Wheel.				Lead.			
		Near.		Off.		Near.		Off.		Near.		Off.		Near.		Off.	
		lbs.	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*	*lbs.*	*ozs.*
1	Halter	2	6	2	6	2	6	2	6	2	5	2	5	2	5	2	5
1	Bridle	3		3		3		3		3	8	3	8	3	8	3	8
1	Coupling-strap				10				10				9				9
1	Collar and hames, complete	21	4	21	4	21	4	21	4	21	6	21	6	21	6	21	6
1	Breast-strap	1	14	1	14					5	4	5	4				
1	Pole-strap									2	9	2	9				
1	Martingale	1	4	1	4												
2	Traces, with chains and spring-tugs, complete	*10	8	*10	8	11	4	11	4	10	14	10	14	13	9	13	9
1	Saddle, complete	17	10	17	10	16	14	16	14	19		†15	15	19		†15	15
1	Saddle-bags, pair of	4	10	4	10	4	10	4	10								
1	Breeching, complete	5	4	5	4					6	1	6	1				
1	Crupper, complete					2	8	2	8					1	14	1	14
1	Saddle-cloth, hair	4		4		4		4									
1	Blanket									4	2	4	2	4	2	4	2
1	Leg-guard	2	11							2	8						
1	Whip		12								12						
	Total weight	75	3	72	6	65	14	66	8	78	5	72	9	65	12	63	4

Scarlet saddle-cloths are used for full-dress only.
* Includes two spring tug-links, weighing 1 pound 6 ounces.
† Includes valise.

Nomenclature of the 3.2-inch field-gun carriage (steel).

- Wheels..
  - Tire.
  - Follies.
  - Spokes.
  - Nave box.
  - Nave box flanges.
  - Nave bolts and nuts.
- Linch pins.
- Linch washers.
- Axle.
- Shoulder washers.
- Brake eyes and straps.
- Axle plates.
- Flasks.
- Upper front transom.
- Lower front transom.
- Middle transom.
- Trail box transoms (2).
- Rear transom.
- Lunette.
- Lunette plate.
- Trail plate.
- Trail handles.
- Double screw and lazy tongs elevating apparatus.
  - Double screw device.
    - Outside (larger) screw.
    - Inside (smaller) screw.
    - Common to both.
      - Guide bar and bolt.
      - Assembling rod.
      - Separator.
      - Hanger bolts and nuts.
    - Large and small bevel gears.
    - Journal nut.
    - Pinion.
    - Pinion shaft.
    - Journal boxes and bolts.
    - Journal-box cap and screw.
    - Crank.
  - Lazy tongs devices.
    - Screw.
    - Cross-head stud.
    - Cross-head screw nut.
    - Journal stud.
    - Journal boxes.
    - Journal-box caps.
    - Screw-cap piece.
    - Hand wheel.
    - Assembling studs (3).
    - Assembling bolt.
    - Assembling nuts and washers.
    - Tong arms (12).
- Cap squares (2).
- Chin bolt.
- Eye bolt.
- Eye-bolt key.
- Eye-bolt key chain.
- Trail-box.
- Trail-box lid.
- Trail-box lid hasp.
- Trail-box turnbuckle.
- Sponge bucket compartment.
- Handspike attachments—front and rear.
- Handspike socket.
- Handspike socket pin and key.
- Handspike.
- Handspike clasps.
- Long sponge toggle and plate.
- Short rammer and sponge attachment.
- Short rammer and sponge clasps.
- Short rammer and sponge-clasp locking latches.
- Sponge-bucket toggle-hole.
- Wheel guards.
- Axle seats.
  - Seat plate.
  - Guard-rail.
  - Guard-rail standard.
  - Guard-rail catch.
  - Guard-rail hinge pin.
  - Guard-rail locking latch.
- Spiral and bow spring brakes.
  - Shoe piece (common to both brakes).
  - Spiral spring, bow springs (4), bow spring bolts and nuts (4).
  - Spring housing (for spiral spring brake).
  - Attachment socket.
  - Attachment.
    - Common to both brakes.
      - Clevis.
      - Clevis bolt and nut.
      - Locking lever.
      - Locking bolt and nut.

3.2-inch field gun carriage consists essentially of—

- Two wheels (Archibald patent, malleable iron nave box and flanges).
- One axle (solid, low, open hearth, steel), with linch-pins and washers—shoulder-washers formed on and part of the axle. On the shoulder-washers are shrunk the brake eye straps. Or wrought-steel tubular axle, shoulder-washers shrunk on.
- Two axle plates (¼″ low, Bessemer steel, riveted together, enveloping the axle).
- Carriage body, bolted by assembling bolts to the axle plates and connected parts consisting of—
  - Two flasks ... Formed each of two plates, low steel, riveted together.
  - Six transoms, by which the flasks are assembled.
    - Upper front transom riveted to flasks under the trunnion beds.
    - Lower front transom riveted to flasks and axle plates over and forward of axle.
    - Middle transom bolted to flasks and axle plates (perforated with two holes for carrying short rammer and sponge).
    - Two trail-box transoms riveted to flasks.
    - Rear transom riveted to flasks.
  - Lunette ... / Lunette plate ... / Trail plate ... All in one piece, riveted to and forming the rear connection of the flasks.
  - Two trail handles ... Riveted to the flasks.
  - Two cap squares ... Attached by chin and eye bolts and key—key held by key chain.
  - Trail box ... To carry gunner's pouches, lanyards, loose primers, cotton waste, etc., and, if desired, gimlet, priming-wire, and vent punch, instead of in the portable tool-box carried under the foot boards of the limber. Formed by the flasks, trail-box transoms, and bottom (of wood and metal) held by flask flanges and inner corrugations.
  - Trail-box lid ... Hinged to the forward trail-box transom and secured to the rear one by hasp and turnbuckle.
  - Sponge-bucket compartment (for bucket when not filled with water). In rear of trail-box, formed by the flasks, rear transom, the rear trail-box transom, and a sheet-metal bottom held by flask flanges and inner corrugations (a hole for toggle in the short sponge and rammer attachment provides for carrying the bucket when filled with water).
  - Handspike attachments ... Front and rear bolted to the lunette plate.
  - Handspike socket ... Attached—hinged—by pin (secured by a key) to the front attachment and constructed to hook under the rear attachment catch-pin.
  - Handspike ... Made of hickory and sheet iron ringed and riveted together—permanently riveted in the handspike socket.
  - Handspike clasps ... For holding the handspike when folded over on the trail, attached to the forward trail-box transom, folding down out of the way when not in use.
  - Long sponge toggle and plate. For securing the long sponge (staff halved and hinged) to the left side of carriage—plate secured by the upper front and lower rear bolts of the left journal box of the elevating apparatus.
  - Short rammer and short sponge. Attachment. Bolted between the flasks in front of axle to the axle plates by the two forward lower front transom bolts, and having two clasps and locking latches that hold the staves, just behind the heads, by means of grooved ferrules, the staves passing in rear through the holes in the middle transom. A hole between the seats of sponge and rammer provides for carrying the sponge bucket.
  - Wheel guards ... Bolted to the sides of the trail.
  - Double screw and lazy tongs elevating apparatus, consisting principally of ....
    - Double screw device.
      - Outside (larger) screw.
      - Inside (smaller) screw
      - Common to both.
        - Guide or radial bar and bolt.
        - Assembling rod.
        - Separator.
        - Hanger, or eye bolts, and nuts.
      - Bronze.
        - Large and small bevel gears.
        - Journal or cross-head nut.
        - Pinion.
      - Pinion shaft.
      - Journal boxes and bolts.
      - Journal-box (left) cap and screw.
      - Crank.
    - Lazy tongs device.
      - Screw.
      - Cross-head stud.
      - Cross-head screw nut.
      - Bronze.
        - Journal stud.
        - Journal boxes.
        - Journal-box caps.
        - Screw cap piece.
        - Hand wheel.
      - Assembling studs (3).
      - Assembling bolt.
      - Assembing nuts and washers.
      - Tong arms (12).

3.2-inch field gun carriage consists essentially of—		
Two axle seats, each consisting of	1 seat plate. 2 guard standards. 1 guard rail. 1 guard-rail key or catch. 1 guard-rail hinge-pin. 1 guard-rail locking-latch.	Attached at the shoulder washers to the axle plates and bolted to the flasks be the two lower front and any middle transom bolts.
Spiral and bow spring brakes	Shoe piece (common to both brakes). Spiral spring—bow springs (2), bow spring bolts and nuts (4). Spring housing (for spiral spring brake).	
	Attachment socket. Attachment-Clevis. Attachment-Clevis bolt and nut. Locking lever. Locking bolt and nut.	Common to both brakes.

3.2-*inch field gun-carriage limber.*

Wheels
- Tire.
- Feilies.
- Spokes.
- Nave box.
- Nave-box flanges.
- Nave bolts and nuts.

Axle.
Linch-pins.
Linch-washers.
Shoulder-washers
Under straps (axle)
The fork.
The fork brace.
The hounds.
Splinter bar.
Foot-boards, front and rear.
Foot-board latch.
Pole.
Pole ferrule.
Pole pad, rubber.
Pole-pad bolt and nut.
Pole prop.
Pole bolt.
Pole-prop eye.
Pole-prop hook.
Pole stop.
Bushing for pole bolt-hole.
Neck yoke stop.
Double-tree.
Double-tree chains and staples.
Double-tree bands (end).
Double-tree hooks (end).
Double-tree stay hooks.
Double-tree bolt.
Double tree bolt plates.
Double-tree bolt strap.
Double-tree bolt brace.
Double-tree guard plates.
Single-trees.
Single-tree eye band.
Single tree hooks.
Single-tree hook bands.
Single-tree hook band springs.
Oil and grease can compartment.
Pintle.
Pintle key.
Pintle-key chain.
Pintle-key chain eye-plate.
Pintle-brace rods.
Hound-brace rods.
Primer and obturator boxes.
Primer and obturator box lids.
Primer and obturator box lid chains.
Ammunition-chest staple.
Ammunition-chest keys and chains.

Ammunition chest.
- Lid.
- Handles (2).
- Hasp.
- Turnbuckle.
- Boot staples.
- Boot buttons.
- Paulin straps.
- Packing, metallic.
- Packing, wood.

Neck yoke.
Neck-yoke pole ring.
Neck-yoke swivel eye-bolt.
Neck-yoke swivel eye-bolt washer.
Neck-yoke swivel eye-bolt plates.
Neck-yoke martingale staples.
Neck-yoke eye bands.
Neck-yoke eye-band rings.
Neck-yoke eye loops.
Neck-yoke eye-loop rollers.
Neck-yoke pads, rubber.

3.2-inch field gun-carriage limber consists essentially of—		
Two wheels, Archibald patent. (Same as for carriage.)		
One wrought steel tubular axle (linch-pin and washers, shoulder washers shrunk and pinned on three under straps).		
The limber body and connected parts consisting of—	The fork	Central part of body formed of two angle irons receiving the pole and pintle body in rear. It passes into and is riveted to the double-tree bolt strap which surrounds and supports the pole. It carries, riveted to it between the flanges, the foot brace and pole stop, to which is pivoted the pole prop hook. In rear of foot boards is the staple for securing the ammunition chest.
	The hounds	Side rails of the body—angle irons. To these on each side in rear of the axle is bolted the primer and obturator boxes.
	The splinter bar	Angle iron. Unites the fork and hounds in front of foot boards.
	Foot boards (wood)	Rear one riveted to hounds and forks. The front one, to which are riveted 3 brackets, is hinged by two strap hinges to the rear one, to give access to pole prop hook, pole bolt, and compartment for oil and grease cans and tool box.
	The pole (wood)	Padded in front with rubber. Neck yoke stop, iron on under side. The hole in rear and for bolting to the fork is lined with thin brass tubing.
	The double-tree (wood)	Banded and hooked at each end for attachment of single-trees. Hole—ironed—in center for attachment to limber by double-tree bolt.
	Double-tree bolt strap	Riveted to fork and supports the pole. Double-tree bolt, bolt strap, and pole prop eye one piece.
	Two single-trees (wood)	Bands at ends and middle, the latter with eye for attachment to double-tree hooks; hooks at ends with spring guards for trace attachment.
	Oil and grease can compartment	A flanged plate of sheet iron under the foot boards riveted to the fork and right hound.
	Pole prop	Permanently secured to the eye on bottoms of the double-tree bolt strap.
	Pole prop hook	For holding up the prop—pivoted to the pole stop.

3.2-inch gun-carriage limber consists essentially of—	The limber body and connected parts consisting of—	Pole bolt	Passes through the fork, the flanges of the double-tree bolt brace and the pole, securing it to the fork.
		Pole stop and support	A flanged piece of plate metal (riveted to fork flanges) on and against which the pole is supported.
		Double-tree bolt-brace	A flanged plate with holes in front for double-tree bolt and through the flanges for pole bolt. It also forms the catch for the foot-board latch.
		Pintle	For connecting the carriage—body bolted between the fork flanges.
		Pintle-key	For securing the lunette.
		Pintle-key chain	For securing the pintle-key to the limber.
		Pintle brace-rods	From the rear hound under strap bolts to the rear pintle-body bolt.
		Hound brace-rods	From the front pintle-body bolt to the ring-bolts of primer and obturator boxes.
		Primer and obturator boxes	Two water-tight cylindrical boxes with screw lids bolted through the bottoms to the axle and by a ring-bolt to the hounds for carrying unbroken boxes of primers and spare obturators.
		Ammunition chest (wood)	Ironed like the old 6 and 12 pounder chests. Three compartments inside, end for projectiles, middle for cartridges and one or two haversacks. The packing—divisions—for projectiles cast bronze, staples on the lids and buttons on the ends, serve to secure a boot for covering haversacks on the rear foot-board.

APPENDIX 16.

PROGRESS REPORT ON MANUFACTURE OF CAST-IRON BODIES AT BUILDERS' IRON FOUNDRY FOR 12-INCH B. L. STEEL-HOOPED MORTARS.

The work has been confined to the preparation of cast-iron bodies for 12-inch B. L. R. mortars, under contract of January 8, 1889.

On the date of contract Captain Lyle furnished the company with data relating to the preparation of the core-arbor for casting by the Rodman method, cooling from the interior by flow of water through the core.

Preparation of flasks and core was completed about February 15, 1889, two flasks being made for use alternately, each flask being made up of cylindrical sections of nearly equal length, with a base plate or cup for the bottom of molds. As the casting is made cylindrical, but one short pattern, a wooden cylinder long enough for one section of flask, is needed for preparation of the mold. The only marked peculiarity of the mold consists in the arrangement for preventing water from penetrating into the sand, when the core-arbor is withdrawn and water is run into the bore itself. Usually castings even for breech-loading guns are made long enough to leave a solid end at the bottom, the core-barrel being supported only at the top, extending low enough to pass through the metal used for the gun, but not quite to the bottom of the mold. To stiffen the core-barrel and make the adjustment more certain, in the operations here, the core is stepped into a cavity at the bottom of the mold.

In preparing the baseplate, a thin pot of cast iron about 17 inches in diameter is placed in the center and the sand is packed around it, leaving the beveled edge of the sides projecting about half an inch into the cavity of the mold. The interior of the pot is then lined to the same level, leaving a cavity for reception of the lower end of the core.

The result is that in casting the molten metal unites with the projecting metal of the pot, making a tight water-joint, with the core passing clear through the gun casting, the whole casting being thus subjected to the cooling effect of the water. As a test of iron to be used, and of the security afforded by the pot at the bottom, two hollow cylinders were cast, the mold for each being made by using a single section of the flask, with the base plate attached.

Water was not used to cool these trial cylinders, but the opportunity was takento test the working of the core covering. A hollow cast-iron pipe was used with flutings formed by longitudinal strips of wrought iron bound to the pipe with wire. This was wrapped with rope and covered with clay.

The first cylinder, of Lanesborough iron from the Lanesborough Iron Company, Pittsfield, Mass., was cast February 20. 1889.

Record of this is given in Appendix A.

In the second cylinder, cast February 25, 1889, Muirkirk iron was used. The record of this is given in Appendix B.

From the results with these cylinders, the Lanesborough iron was selected for the mortar bodies, but small amounts of Muirkirk iron (remelted) from this trial cylinder have been added in some cases.

An experimental mortar body was cast March 12, 1889, the record being given in Appendix C.

This proved of excellent quality in respect to metal, but a flaking of the core covering caused such enlargements of the bore that it could not fulfill the requirements as to dimensions, and it was not presented for acceptance. It was, however, bored out to 11.7 inches and partly finished on the exterior.

From a misunderstanding of the requirements in cooling, the foreman tried to regulate the flow of water to keep the temperature of outflow as nearly the same as possible, involving frequent change of rate and much irregularity in the record, which is only partially tabulated.

The flow with the next following casting being also very irregular, a table is submitted, giving for each hour the product of the average rate of flow per minute, and the average rise of temperature from that of inflow during the hour. This corresponds to the number of gallons of water raised, 60°.

No account has been taken of the slight difference of specific heat of water at different temperatures, as the errors of observation probably far exceed such variations.

As a means of readier comparison, this table is given in connection with similar tables for the mortar bodies cast at the South Boston Iron Works, and described in Reports of Chief of Ordnance, page 196, of 1885, and page 323, of 1886; also for the mortar bodies cast here later.

These tables, as presented, give but a rough approximation, as much trouble has been experienced in regulating the flow and determining its rate, the water-meter used for this purpose having frequently given out, causing irregularities in the record. This table is given in Appendix I.

Mortar body No. 1 was cast April 6, 1889. The record is given in Appendix D. This body was offered for acceptance June 6, 1889.

Mortar body No. 2 was cast May 18, 1889. The record is given in Appendix E. This body was bored to 11.6 inches, and partly finished outside, and the test specimens were nearly finished at the end of June.

Mortar body No. 3 was cast May 28, 1889. The record is given in Appendix F. This was partially turned and bored at the end of June.

Mortar body No. 4 was cast June 11, 1889. The record is given in Appendix G. Work had begun on it in boring lathe at the end of June.

Mortar body No. 5 was cast June 20, 1889. Record is given in Appendix H.

To further test the quality of metal in the experimental casting, condemned on account of irregularity of bore, an additional test disk was ordered cut at a distance removed from the bottom of casting, and, in addition to this, six longitudinal bars 60 inches long, of section 4½ inches by 4½ inches, were ordered cut from the remaining portion for special test at Watertown Arsenal.

Very respectfully, your obedient servant,

A. H. RUSSELL,
Captain, Ordnance Department, U. S. Army.

The CHIEF OF ORDNANCE, *U. S. Army.*

APPENDIX A.

TRIAL CYLINDER OF LANESBOROUGH IRON, CAST FEBRUARY 20, 1889.

[Heat No. 74. Furnace No. 2. Builders' Iron Foundry.]

CHARGE OF FURNACE.

Lanesborough pig, 9,000 pounds, No. 2; 9,000 pounds, No. 3; 2,000 pounds, No. 4.
Tests of pig, 24,000 and 24,400 pounds tenacity.
Furnace fired 7.45 a. m.
Metal down 11.35 a. m.
Test points taken: No. 1, 12 m.; No. 2, 1 p. m.; No. 3, 1.15 p. m.; No. 4, 1.50 p. m.; No. 5, 1.55 p. m.; No. 6, 2.30 p. m.
Points showed gradual increase of hardness from first to last, mottled appearance coming up to 1 inch square.
Casting made 2.30 p. m.
Time of filling mold, 5 minutes.
Casting left in mold till 9 a. m., February 25, 1889.
Coal used, 11,000 pounds Pennsylvania gas coal.

The following tests of tenacity were taken on the Wade testing machine at the Builders' Iron Foundry, from a slice cut about 3 inches from bottom of casting of dimensions required for breech test disk for mortars under contract:

		Tenacity.
Longitudinal:		
Middle	pounds..	30,400
Outside	do	30,100
Inside	do	29,700
Tangential	do	31,600
Radial	do	30,000
Average	do	30,360

Remelted pig of this heat was used, 1,000 pounds in casting for mortar body No. 4.

APPENDIX B.

TRIAL CYLINDER OF MUIRKIRK IRON, CAST FEBRUARY 25, 1889.

[Heat No. 75. Furnace No. 2. Builders' Iron Foundry.]

CHARGE OF FURNACE.

Muirkirk pig, 8,000 pounds, No. 2; 8,000 pounds, No. 3; 4,000 pounds, No. 4.
Tests of pig, 23,800 and 26,800 tenacity.
Coal used, 12,550 pounds Pennsylvania gas coal.
Furnace fired 8.30 a. m.
Metal down 12.45 p. m.
Test points taken: No. 1, 1 p. m. (softer than last heat); No. 2, 1.45 p. m.; No. 3, 2.30 p. m.; Nos. 4 and 5, 3.10 p. m.; No. 6, 3.55 p. m.; No. 7, 4.30 p. m.
Did not show as marked change during fusion as Lanesborough cylinder.
On seventh point mottled appearance not above ⅛-inch section.
Furnace tapped 4.38 p. m.
Time of filling mold, one and one-half minutes.
Metal hotter than before.

The following tests were made from a test disk similar to previous ones:

		Tenacity.
Longitudinal:		
Outside	pounds..	25,300
Inside	do	23,000
Middle	do	25,400
Radial	do	25,700
Average	do	24,850

APPENDIX C.

RECORD OF EXPERIMENTAL CASTING, MARCH 12, 1889, OF BODY FOR 12-INCH B. L. R. MORTAR.

Furnace No. 2. Cast on Rodman principle, with water core. A true cylinder, with mortar to be cut out in lathe. Remelted iron was from experimental cylinder air furnace heat, No. 74, which was as follows:

Charge, Lanesborough Iron.

	Pounds.
Remelted No. 4	11,962
No. 4 pig	5,080
No. 3 pig	7,910
No. 2 pig	15,048
Total	40,000

Coal used estimated 15,000 pounds, called Pennsylvania gas coal.
Fire started March 12, 1889, 4 a. m.
Iron melted, 11 a. m.
First point, 10.55 a. m.
Second point, 12.50 p. m.
Third point, 1.22 p. m.
Fourth point, 2.05 p. m.
Fifth, at time of tapping, 2.13 p. m.
Points increased in hardness until No. 3, which proved white at ½-inch square, and even mottled at 1½-inches square; fourth and fifth about the same.
Weight of casting, 35,000 pounds.
Tapped furnace at 2.13 p. m.
Cast finished at 2.20; seven minutes.
Water turned into arbor at 2.13 p. m., and continued to flow at rate stated below.

Date.	Hour.	Temperature of inflow.	Temperature of outflow.	Rate of water per minute.
1889.		*Degrees.*	*Degrees.*	*Gallons.*
March 12	2.13 p. m.	38	38	22.5
	2.25 p. m.	38	64	22.5
	2.35 p. m.	38	85	22.5
	2.40 p. m.	38	85	22.5
	3.00 p. m.	38	88	19
	3.30 p. m.	38	88	13
	4.00 p. m.	38	100	7.5
	4.30 p. m.	38	100	7.5
	5.00 p. m.	38	100	6
	5.30 p. m.	38	95	6
	6.00 p. m.	38	90	6
	7.00 p. m.	38	90	6
	8.00 p. m.	38	100	5.6
	9.00 p. m.	38	100	5.6
	10.00 p. m.	38	100	5.6
	11.00 p. m.	38	100	5.6
	12.00 mid.	38	100	5.6
March 13	1.00 a. m.	38	100	5.6

From this time to 6 o'clock p. m. temperature gradually fell to 95°, with supply correspondingly reduced to 3 gallons per minute, at which time tried to withdraw core arbor, but rope had not been allowed to burn enough to free the arbor.

Water was again turned on and allowed to run at rate of 1 gallon per minute; temperature of outflow gradually rose to 185°, as shown by smoke escaping from top of core.

March 14, 1889.—Rate of supply continued at 1 gallon until 7 a. m., March 14; outflow 135°. At this time supply was increased until outflow was reduced to 80° at 9.45 a. m., when core arbor was easily removed. At 11.45 a. m. water was put directly into barrel through pipe reaching nearly to bottom. At first it was all turned into steam. Rate of supply at 58° Fahr. was gradually increased, until at 12.15 p. m. boiling stopped and at 12.30 p. m. had fallen to 160°.

Rate of supply at this time 3 gallons per minute, at which rate it continued until 9.30 a. m., March 15 when temperature outflow had fallen to 80°. Top section of flask removed at 10 a. m. Water continued in constantly-reduced quantities until 9.45 a. m., March 16, when it was finally shut off, and two more sections of flask removed. Water left in barrel did not rise above 90° thereafter.

Fire in pit lighted 4 p. m. March 12, burned until 7 a. m. March 13.

Temperature of pit.

	Degrees.
March 12, 10.30 p. m	175
March 13, 7 a. m	165
March 13, 11 a. m	135
March 14, 7 a. m	110

Tests from Builders' Iron Foundry machine.—Plug from surplus pig 2½ inches square in section broke at 35,700 pounds. Plug from runner first section of flask broke at 29,500 pounds. Plug from runner fourth section of flask broke at 30,000 pounds. Two plugs drilled out of casting just above muzzle of mortar broke at 32,000 and 30,700 pounds.

The average tenacity of specimens from muzzle test disk was 31,348 pounds.

Specific gravity and hardness of specimens from muzzle disk.

Specimen.	Specific gravity.	Hardness.
Inner	7.2495	16.15
Outer	7.2501	15.83
Middle	7.2472	15.83

The tension rings of this casting showed but slight expansion at bore and contraction at outer surface.

Fullreport of tests from this casting will be given in a special report, embracing the additional test disks taken in cutting up the casting.

Thebreech test disk was cut close to the bottom of the casting, so that the influence of that cooling surface was felt in test of specimens, and this was particularly apparent where the rim of the cast-iron pot at bottom of mold projected into the casting. This has led to taking the breech test disk from 6 to 9 inches from the bottom.

APPENDIX D.

Statement of fabrication of ordnance for the service of the United States, by Builders Iron Foundry at the Builders Iron Foundry under the supervision of Capt. A. H. Russell, U. S. Army.

[12-inch B. L. mortar body. Foundry No. 78. Reg. No. 1. Cast April 6, 1889. Inspected June 6, 1389.]

CHARGE.

Iron used.

Grade of iron: Lanesborough—	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
		Pounds.		
No. 2		14,000		
No. 3		12,000		
No. 4		10,500		
Remelted; heat 76; condemned casting		3,500		
Total		40,000		40,000

Coal consumed.

	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
Melting	....	....	....	....
Fusion	....	....	....	....
Total	....	14,000	....	14,000

Record of casting.

Furnaces fired April 6 at 2.45 a. m.
Metal down at 10 a. m.
Time of melting, 7.15 hours.
Time in fusion, 2½ hours.
Gun cast at 12.30 p. m.
Time occupied in casting, 7½ minutes.
Temperature of water entering core-barrel, 45°.
Rate of water per minute, 10½ gallons.
Fire kindled in pit, 1 p. m.
Fire in pit went out April 7, 10 p. m.
Fire in pit burned very irregularly 83 hours.
Water shut off April 8, at 4.40 p. m.
Core-barrel removed at 4.40 p. m.
Water entered gun at 5.20 p. m.
Rate of water per minute, 10½ gallons.
Temperature of water entering gun, 45°.
Temperature of water leaving gun in 60 minutes, 110°.
Rate of water changed at 7 p. m. to 6 gallons.
Total time in cooling gun, 92½ hours.

Cooling tables.

Hrs.	Degrees.		Hrs.	Degrees.		Hrs.	Degrees.		Hrs.	Degrees.	
CORE-BARREL.											
1	[44.1]	108	14	[19.5]	105	27	[14.3]	102	40	[10.5]	97
a2	[31.5]	120	15	[17.9]	100	28	[14.2]	102	41	[10.0]	95
3	[31.5]	120	16	[17.9]	100	29	[13.8]	100	e42	[9.6]	93
4	[31.5]	120	17	[17.9]	100	30	[13.8]	100	43	[11.0]	108
5	[29.4]	115	18	[16.3]	95	31	[13.0]	97	44	[11.0]	108
6	[27.3]	110	19	[17.2]	98	32	[12.5]	95	45	[11.4]	110
b7	[21.0]	95	20	[17.6]	99	d33	[12.5]	95	46	[13.0]	120
8	[26.0]	125	21	[15.6]	93	34	[12.6]	108	f47	[11.0]	108
9	[25.4]	123	22	[15.3]	92	35	[12.6]	108	48	[11.3]	120
10	[25.0]	122	c23	[15.3]	92	36	[12.2]	106	49	[11.6]	122
11	[24.5]	120	24	[14.9]	100	37	[11.6]	103	50	[11.3]	120
12	[22.8]	115	25	[14.5]	103	38	[11.0]	100	51	[11.1]	118
13	[21.0]	110	26	[14.5]	103	39	[10.6]	98	g52	[11.1]	118
CORE-BARREL REMOVED.											
53	....	....	63	[16.0]	85	73	[4.5]	80	83	[3.6]	98
h54	....	160	64	[15.2]	83	l74	[4.4]	80	84	[3.5]	97
55	[26.0]	110	65	[14.0]	80	75	[2.7]	85	85	[3.3]	95
56	[26.0]	110	i66	[14.0]	80	76	[3.3]	95	86	[3.2]	93
57	[22.8]	102	67	[9.5]	83	77	[3.7]	100	87	[3.1]	91
58	[22.0]	100	68	[8.8]	80	78	[3.7]	102	88	[3.0]	90
59	[21.2]	98	j69	[8.7]	80	79	[3.7]	100	89	[3.0]	90
60	[19.6]	94	70	[6.0]	85	80	[3.7]	100	90	[3.8]	87
61	[18.0]	90	k71	[5.6]	82	81	[3.7]	100	91	[2.8]	87
62	[16.8]	87	72	[5.1]	85	82	[3.6]	98	92	[2.7]	85

On account of irregularity of flow, figures are entered in brackets indicating the number of degrees that would have been added by the same rate of cooling to water flowing at the rate of 15 gallons per minute, as in the next following casting.

[a] Supply reduced to 6 13/16 gallons.
[b] Supply reduced to 4½ gallons.
[c] Supply reduced to 3¾ gallons.
[d] Supply reduced to 3 gallons.
[e] Supply reduced to 2⅝ gallons.
[f] Supply reduced to 2¼ gallons.
[g] Water shut off, arbor removed.
[h] Supply directly to bore; rate, 6 gallons per minute.
[i] Supply reduced to 3¾ gallons per minute.
[j] Supply reduced to 2¼ gallons per minute.
[k] Supply reduced to 1 3/16 gallons per minute.
[l] Supply reduced to 1 gallon per minute.

MECHANICAL TESTS.

Specific gravity and hardness.

Specimen.	Hardness.	Density.
12 M R. T R. M T 5 M..........	16.56	7.2380
12 M R¹, T R 2 B T 5 M..........	16.23	7.2478

Tensile strength.

Specimens.	Diameter of specimen.	Area of cross-section.	Breaking weight.	Tenacity.
	Inches.	*Sq. in.*	*Pounds.*	*Pounds.*
12 M R. T R 1 M T 3 1	1.129	1	29,920	29,920
M T 40	1.129	1	29,880	29,880
M T 5 M..............	1.129	1	31,070	31,070
12 M R. T R 2 B T 3 I..................	1.129	1	31,060	31,060
B T 40..............	1.129	1	32,810	32,810
B T 5 M	1.129	1	33,080	33,080
B L 6 I	1.129	1	32,010	32,010
B L 7 O..............	1.129	1	32,840	32,840
B L 8 M	1.129	1	31,690	31,690

Initial tension.

	Inner ring.					Outer ring.				
	Diameter x of ring.	Diameter x x of ring.	Extension per inch.	Initial compression.	Ratio of initial compression to ultimate strength 54,000 pounds.	Diameter x of ring.	Diameter x x of ring.	Contraction per inch.	Initial tension.	Ratio of initial tension to tenacity.
	Inches.	*Inches.*	*Inches.*	*Pounds.*						
Breech:										
Before cutting	13.0318	13.0365	....	....	....	....	....	....	....	....
After cutting	13.0335	13.0380	....	....	....	No perceptible change.			....	....
Difference .	+.0017	+.0015	....	....	....	....	....	....	....	....
Mean :......	+.0016		0.000123	3,100	.0574	....	....	....	....	....
Muzzle:										
Before cutting	13.0005	13.0025	....	....	....	....	....	....	....	....
After cutting	13.0015	13.0035	....	....	....	....	....	....	....	....
Difference .	+.001	+.001	....	....	....	....	....	....	....	....
Mean	+.001		0.000077	3,000	.0555	....	....	....	....	....

REMARKS.—The casting is very even in quality. Slight enlargements of bore in cutting have caused this body to be accepted provisionally. The measurements of tension rings, while indicating no contraction of the outer ring, show an expansion of the inner rings and a difference of tension in the desired direction between the metal near the bore and near the exterior.

APPENDIX E.

tement of fabrication of ordnance by Builders' Iron Foundry, at the Builders' Iron Foundry.

[12-inch B. L. R. mortar. Foundry No. 79. Reg. No. 2.]

CHARGE.

Iron used.

Grade of iron: Lanesborough.	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
		Pounds.		
No. 2	....	29,000	....	....
No. 4	....	1,000	....	....
No. 4½	....	4,000	....	....
No. 3, soft	....	....	....	....
Remelted, trial cylinder heat 74 and heat 78, 3½	....	9,000	....	....
Total	....	43,000	....	....

Coal consumed.

	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
Melting	....	....	....	....
Fusion	....	....	....	....
Total	....	14,500	....	14,500

RECORD OF CASTING.

naces fired May 18, at 2.45 a. m.
tal down, at 10 a. m.
ne of melting, 7.15 hours.
ne in fusion, 4.43 hours.
n cast, at 2.44 p. m.
ne occupied in casting, 7 minutes.
nperature of water entering core-bar-
el, 64 degrees.
nperature of water leaving core-bar-
el, 110 degrees.
e of water per minute, 15 gallons.
e kindled in pit, 3 p. m.
e in pit went out May 19, 9 a. m.
nperature of pit in 24 hours, 200 de-
rees.

Temperature of pit in 48 hours, 150 degrees.
Fire in pit burned, 18 hours
Water shut off May 19, at 9.30 a. m.
Core-barrel removed, at 9.45 a. m.
Water entered gun, at 12.30 p. m.
Rate of water per minute, 11 gallons.
Temperature of water entering gun, 64 degrees.
Temperature of water leaving gun in 10 minutes, 90 degrees.
Total time in cooling gun, 58 hours.
Total time to shutting off water, 66 hours.

COOLING TABLES.

CORE-BARREL.

Min.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
0.10	90	1	110	6	95	10	91	14	83	18	78
0.20	95	2	105	7	95	11	89	15	80	19	78
0.30	100	3	100	8	94	12	88	16	80	20	(*)
0.40	105	4	98	9	93	13	85	17	78	21	....
0.50	110	5	95								

CORE-BARREL REMOVED.

Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
22	212	30	152	38	104	46	83	53	72	60	70
23	170	31	150	39	98	47	81	54	72	61	70
24	170	32	147	40	92	48	79	55	72	62	70
25	160	33	144	41	86	49	78	56	71	63	70
26	158	34	139	42	85	50	76	57	71	64	70
27	155	35	127	43	83	51	74	58	71	65	70
28	154	36	117	44	83	52	73	59	70	66	70
29	153	37	109	45	83						

* Arbor taken out.

Rate of flow through arbor kept constant at 15 gallons per minute.
Rate of flow through bore kept constant at 11 gallons per minute.

APPENDIX F.

Statement of fabrication of ordnance by Builders' Iron Foundry, at the Builders' Iron Foundry.

[12-inch B. L. R. mortar. Foundry No. 80; Reg. No. 3.]

CHARGE.

Iron used.

Grade of iron: Lanesborough.	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
No. 2	....	25,200	....	....
No. 4½	....	1,260	....	....
No. 3, hard	....	....	....	....
No. 3, soft	....	....	....	....
Remelted, heats 76, 78, 3½	....	15,120	....	....
Total	....	41,580	....	41,580

Coal consumed.

	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
Melting	....	10,000	....	....
Fusion	....	6,000	....	....
Total	....	16,000	....	16,000

RECORD OF CASTING.

May 23, at 4 a. m.
12.30 p. m.
;, 8.30 hours.
4 hours.
2 p. m.
n casting, 7 minutes.
water entering core-bar-
i.
water leaving core-bar-
i.
er minute, 15 gallons.

Fire kindled in pit, 5 p. m.
Fire in pit went out, May 29, 11 a. m.
Fire in pit burned, 18 hours.
Water shut off, May 29, at 2.40 p. m.
Core-barrel removed, at 3.40 p. m.
Water entered gun, at 4.40 p. m.
Rate of water per minute, 15 gallons.
Temperature of water entering gun, 66 degrees.
Total time in cooling gun, 52 hours.

COOLING TABLES.

CORE-BARREL.

Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
90	3	97	7	95	11	94	15	90	19	82
92	4	97	8	95	12	94	16	87	20	82
94	5	96	9	95	13	93	17	86	21	82
96	6	96	10	94	14	91	18	83	22	82
97										

CORE-BARREL REMOVED.

Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
(*)	28	132	33	112	38	95	43	79	48	73
(†)	29	128	34	106	39	90	44	77	49	73
147	30	124	35	100	40	86	45	76	50	72
141	31	120	36	98	41	82	46	75	51	71
135	32	116	37	96	42	80	47	74	52	71

* Taking out arbor.

† Water turned into bore.

APPENDIX G.

rication of ordnance by Builders' Iron Foundry, at the Builders' Iron Foundry.

[12-inch B. L. R. mortar. Foundry No. 81. Reg. No. 4.]

CHARGE.

Iron used.

Grade of iron, Lanesborough.	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
2		24,000		
1		2,000		
1½		8,000		
elted, heat 80, No. 3½		6,000		
rkirk, remelted, heat trial cylinder, 2		1,000		
Total		41,000		

Statement of fabrication of ordnance by Builders' Iron Foundry, at the Builders' Iron Foundry—Continued.

CHARGE—Continued.

Coal consumed.

	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
Melting				
Fusion				
Total		17,250		17,250

RECORD OF CASTING.

Furnaces fired, June 11, 1889, at 4 a. m.
Metal down, at 11.40. a. m.
Time of melting, seven hours and forty minutes.
Time in fusion, four hours and thirty minutes.
Gun cast, at 4.11 p. m.
Time occupied in casting, six and two-thirds minutes.
Temperature of water entering core-barrel, 72 degrees.
Temperature of water leaving core-barrel, 99 degrees.
Rate of water per minute, 15 gallons.
Fire kindled in pit, 4.30 p. m.
Fire in pit went out, June 12, 1889, 8 a. m.
Fire in pit burned fifteen hours and thirty minutes.
Water shut off, June 12, 1889. at 11.30 a. m.
Core-barrel removed, at 11.35 a. m.
Water entered gun, at 1.30 p. m.
Rate of water per minute, 15 gallons.
Temperature of water entering gun, 72 degrees.
Temperature of water leaving gun in twenty minutes, 180 degrees.
Total time in cooling gun, fifty-one hours.
Total time to shutting off water, sixty-three hours.

COOLING TABLES.

CORE-BARREL.

Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
1	99	5	95	9	93	13	89	17	85	20	.....
2	97	6	94	10	94	14	87	18	85	21	180
3	96	7	94	11	92	15	86	19	85	22	160
4	95	8	93	12	90	16	85				

CORE-BARREL REMOVED.

Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
23	143	30	105	37	95	44	80	51	72	58	72
24	135	31	105	38	95	45	78	52	72	59	72
25	128	32	103	39	90	46	76	53	72	60	72
26	120	33	102	40	89	47	75	54	72	61	72
27	115	34	102	41	86	48	74	55	72	62	72
28	112	35	100	42	84	49	74	56	72	63	72
29	109	36	100	43	82	50	73	57	72		

APPENDIX H.

t of fabrication of ordnance, by Builders' Iron Foundry, at the Builders' Iron Foundry.

[12 inch B. L. R. mortar. Foundry No. 82, Reg. No. 5.]

CHARGE.

Iron used.

Grade of iron: Lanesborough—	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
No. 2	....	21700	....	....
No. 4½	....	1400	....	....
No. 3, hard	....	....	....	....
No. 3, soft	....	....	....	....
Remelted, Heats 76 and 78 } 3½	....	18400	....	....
Total	....	41500	....	41500

Coal consumed.

	Furnaces.			
	No. 1.	No. 2.	No. 3.	Total.
Melting	....	....	....	....
Fusion	....	....	....	....
Total	....	17250	....	17250

RECORD OF CASTING.

es fired June 20, 1889, at 3.30 a. m.
own at 11.00 a. m.
melting, seven and a half hours.
fusion, six hours and eleven min-

st at 5.19 p. m.
cupied in casting, —— minutes.
ature of water entering core-bar-
2 degrees.
water per minute, 15 gallons.
dled in pit 5.30 p. m.

Fire in pit burned fifteen hours.

Fire in pit went out June 21, 1889, 8.30 a. m.

Water shut off June 21, at 2.20 p. m.

Water entered gun at 5.15 p. m.

Rate of water per minute, 15 gallons.

Temperature of water entering gun, 72 degrees.

Total time in cooling gun, seventy-two hours.

COOLING TABLES.

Core-barrel.

Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
1	120	5	108	9	103	13	101	16	97	19	92
2	115	6	108	10	103	14	100	17	96	20	92
3	112	7	105	11	102	15	98	18	94	21	92
4	108	8	105	12	102						

Core-barrel removed.

Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.	Hrs.	Degs.
25	155	33	135	41	98	49	88	57	83	65	76
26	150	34	134	42	93	50	88	58	82	66	76
27	150	35	128	43	89	51	87	59	82	67	76
28	147	36	124	44	89	52	87	60	80	68	76
29	147	37	118	45	89	53	86	61	78	69	75
30	143	38	113	46	87	54	86	62	78	70	75
31	140	39	108	47	87	55	84	63	77	71	73
32	138	40	103	48	88	56	84	64	77	72	73

APPENDIX I.

Comparative cooling tables.

Hour of cooling.	Quantity of water raised 60° Fah., in each hour.							
	M. L. mortar body (Report chief of Ordnance, 1885, p. 196.) *a*	B. L. mortar body (Report chief of Ordnance, 1886, p. 323). *a*	Experimental casting for B. L. mortar body, March 12, 1889. *b*	Mortar body No. 1 April 6, 1889. *c*	Cast-iron body No. 2, May 18, 1889, 12-inch B. L. R., mortar. *d*	Cast-iron body No. 3, 12-inch B. L. R., mortar, May 28, 1889. *e*	Cast-iron body No. 4, 12-inch B. L. R. mortar, June 11, 1889. *f*	Cast-iron body No. 5, 12-inch B. L. R. mortar, June 20, 1889. *g*
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
1	310	305	500	500.0	565.5	420.0	300.0	342.0
2	610	599	470	461.0	652.0	457.5	390.0	682.5
3	590	567	330	435.0	577.5	465.0	367.5	622.5
4	570	525	360	423.0	525.0	465.0	352.5	570.0
5	550	483	384	406.0	487.5	457.5	345.0	540.0
6	520	451.5	372	377.0	465.0	450.0	337.5	540.0
7	490	430.5	347	348.0	465.0	442.5	330.0	517.5
8	470	409.5	347	347.0	457.5	435.0	322.5	495.0
9	450	399	347	343.0	442.5	435.0	315.0	480.0
10	430	388.5	347	339.0	420.0	427.5	307.5	465.0
11	410	378	347	326.0	390.0	420.0	300.0	457.5
12	380	367.5	341	308.0	367.5	420.0	285.0	450.0
13	340	357	336	286.0	337.5	412.5	262.5	442.5
14	310	346.5	330	264.0	300.0	390.0	240.0	427.5
15	(*h*)	325.5	324	242.0	262.5	367.5	217.5	405.0
16	635	315	319	233.0	240.0	337.5	202.5	382.5
17	1,250	315	270	229.0	225.0	307.5	195.0	367.5
18	1,155	309.75	360	229.0	210.0	277.5	195.0	345.0
19	1,155	304.5	320	229.0	210.0	247.5	195.0	315.0
20	1,110	304.5	200	229.0	(*h*)	240.0	(*h*)	300.0
21	1,070	304.5	200	211.0	....	240.0	....	300.0
22	1,035	304.5	160	207.0	....	240.0	1,470.0	(*h*)
23	995	304.5	117	192.0	1,397.0	(*h*)	1,192.5	....
24	950	304.5	117	197.0	1,166.0	....	1,005.0	....
25	910	299.25	117	196.0	1,111.0	....	892.5	604.0
26	875	294	114	195.0	1,045.0	1,170.0	780.0	1,207.5
27	845	283.5	111	194.0	1,017.5	1,080.0	682.5	1,170.0
28	810	273	(*i*)	194.0	995.5	1,012.5	622.5	1,147.5
29	775	262.5	147	184.0	984.5	960.0	577.5	1,102.5
30	730	252	147	184.0	973.5	900.0	525.0	1,072.5
31	670	252	147	177.0	957.0	840.0	495.0	1,042.5
32	610	241.5	140	173.0	929.5	780.0	480.0	1,005.0
33	540	231	130	172.0	896.5	720.0	457.5	967.5
34	465	231	120	172.0	852.5	645.0	450.0	937.5
35	395	220.5	110	169.0	759.0	555.0	435.0	885.0
36	375	210	100	166.0	638.0	495.0	420.0	810.0
37	265	194.5	95	158.0	539.0	465.0	382.5	735.0
38	224	168	90	158.0	467.5	443.5	345.0	652.5
39	200	147	85	157.0	407.0	397.5	307.5	577.5
40	184	(*h*)	80	157.0	341.0	330.0	262.5	502.5
41	168	410	85	156.0	275.0	270.0	232.5	427.5
42	152	815	90	156.0	236.5	225.0	195.0	352.5
43	138	790	60	155.0	220.0	202.5	165.0	285.0
44	126	745	(*k*)	155.0	209.0	180.0	135.0	255.0
45	114	650	(*l*)	155.0	209.0	157.5	105.0	255.0
46	102	530	450	155.0	209.0	142.5	75.0	240.0
47	92	440	276	154.0	198.0	127.5	52.5	225.0
48	88	370	270	154.0	176.0	112.5	37.5	232.5
49	88	315	255	154.0	159.5	105.0	30.0	240.0
50	84	240	240	153.0	143.0	97.5	22.5	240.0
51	80	180	231	153.0	121.0	82.5	7.5	232.5
52	76	155	216	153.0	104.5	75.0	....	225.0
53	68	130	210	(*h*)	93.5	....	....	217.5
54	60	120	210	690.0	88.0	....	....	210.0
55	56	115	210	358.0	88.0	....	....	195.0
56	52	110	210	319.0	82.5	....	....	180.0
57	48	105	210	319.0	77.0	....	....	172.5

a Weight of charge 27 tons; weight of casting unknown.
b Weight of charge 40,000 pounds; weight of casting 35,000 pounds.
c Weight of charge 40,000 pounds; weight of casting 35,000 pounds.
d Weight of charge 48,000 pounds; weight of casting 37,000 pounds.
e Weight of charge 41,580 pounds; weight of casting 36,000 pounds.
f Weight of charge 41,000 pounds; weight of casting 36,000 pounds.
g Weight of charge 41,500 pounds; weight of casting 36,000 pounds.
h Core arbor removed.
i Water off; trying to remove arbor; steam formed in arbor.
k Water off; core arbor removed.
l Water turned on, slowly at first; escaped in steam; then boiled half an hour.

Comparative cooling tables—Continued.

Hour of cooling.	Quantity of water raised 60° Fah., in each hour.							
	M. L. mortar body (Report chief of Ordnance, 1885, p. 196.) *a*	B. L. mortar body (Report chief of Ordnance, 1886, p. 323). *a*	Experimental casting for B. L. mortar body, March 12, 1889. *b*	Mortar body No. 1 April 6, 1889. *c*	Cast-iron body No. 2, May 18, 1889, 12-inch B. L. R., mortar. *d*	Cast-iron body No. 3, 12-inch B. L. R., mortar, May 28, 1889. *e*	Cast-iron body No. 4, 12-inch B. L. R., mortar, June 11, 1889. *f*	Cast-iron body No. 5, 12-inch B. L. R., mortar, June 20, 1889. *g*.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
58	44	95	210	302.0	77.5	....	....	157.5
59	38	90	210	297.0	71.0	....	....	150.0
60	34	85	210	292.0	66.0	....	....	135.0
61	32	80	210	269.0	66.0	....	....	105.0
62	30	80	210	247.0	66.0	....	....	90.0
63	28	95	210	231.0	66.0	....	....	82.5
64	28	90	210	220.0	66.0	....	....	75.0
65	26	70	180	209.0	66.0	....	....	67.5
66	24	65	150	193.0	66.0	....	....	60.0
67	24	55	60	192.0	....	....	....	60.0
68	22	45	36	160.0	....	....	....	60.0
69	18	35	36	110.0	....	....	....	52.5
70	16	30	36	97.0	....	....	....	45.0
71	16	30	36	76.0	....	....	....	30.0
72	16	30	36	71.0	....	....	....	15.0
73	16	30	36	66.0	....	....	....	....
74	16	30	36	63.0	....	....	....	....
75	16	30	36	59.0	....	....	....	....
76	16	30	36	57.0	....	....	....	....
77	16	30	36	55.0	....	....	....	....
78	16	30	36	53.0	....	....	....	....
79	16	25	36	51.0	....	....	....	....
80	16	20	36	49.0	....	....	....	....
81	14	20	36	49.0	....	....	....	....
82	12	20	36	49.0	....	....	....	....
83	10	20	36	48.0	....	....	....	....
84	....	20	36	48.0	....	....	....	....
85	....	20	36	47.0	....	....	....	....
86	....	20	36	45.0	....	....	....	....
87	....	20	36	43.0	....	....	....	....
88	....	....	36	41.0	....	....	....	....
89	....	....	36	40.0	....	....	....	....
90	....	....	36	40.0	....	....	....	....
91	....	....	36	39.0	....	....	....	....
92	....	....	....	38.0	....	....	....	....

a Weight of charge 27 tons; weight of casting unknown.
b Weight of charge 40,000 pounds; weight of casting 35,000 pounds.
c Weight of charge 40,000 pounds; weight of casting 35,000 pounds.
d Weight of charge 43,000 pounds; weight of casting 37,000 pounds.
e Weight of charge 41,580 pounds; weight of casting 36,000 pounds.
f Weight of charge 41,000 pounds; weight of casting 36,000 pounds.
g Weight of charge 41,500 pounds; weight of casting 36,000 pounds.

APPENDIX 17.

SHRINKAGES, RESISTANCE, ETC., OF 12-INCH B. L. RIFLED MORTAR, CAST-IRON, HOOPED WITH STEEL.

[Type mortar; model, 1886; weight, 14.25 tons.]

(1 plate.)

The following computations are based primarily upon a value for the modulus of elasticity of the cast-iron 18,000,000 and of the steel 30,000,000 pounds; also upon the supposition that the initial tension of the cast-iron body (hollow casting) may be neglected in estimating the effect to be produced by the shrinkages. The modulus of the steel may be considered fixed with sufficient accuracy, and probably also that of the cast-iron; yet it is possible that it may be found expedient to modify the latter, and consequently the shrinkages as the work of manufacture of the mortars progresses. This will be determined by careful observation of the effect produced by the shrinkages, especially the first, in compressing the bore.

In general, supposing the first shrinkage to have been accurately applied, if the measured compression of bore is greater than the anticipated it will indicate that the value 18,000,000 is too high, and the reverse if the measured compression is less than the anticipated. If it be found after the first shrinkage in any mortar that the measured compression of bore is more than 0."001, from carefully made average measurements, greater than the anticipated, then a correction must be applied to the second shrinkage, as hereinafter indicated. If, however, the compression of bore from first shrinkage is less than the anticipated no correction of the second shrinkage will be made, since the values here given will not admit of a material increase. Care should be taken in turning for the first shrinkage not to fall below the minimum diameter allowed.

Probably the permissible adjustment of the second shrinkage will obviate any recast of the first shrinkages as now given because of the possible inadequacy of the value adopted for the modulus of cast-iron; at all events no such recast will be made unless it shall be found from the average result obtained with the first five mortars that the value 18,000,000 is materially erroneous. In this connection the apparent modulus of the iron as determined by the tests of long specimens (tension and compression) at Watertown Arsenal should also be observed for comparison.

The effect of initial tension in the casting should not be apparent until the second shrinkage is applied, since presumably this initial compression of bore added to the compression induced by the first shrinkage will not cause the elastic limit of the metal under compression to be exceeded. Thus we assume that the metal at the bore may be compressed to a working limit $\rho_0 = 22{,}400$ pounds per square inch. Now, the greatest compression due to the first shrinkage is in the powder chamber, where, approximately, it will be 11,500 pounds (5.174 tons), and the initial compression of casting added to this may be also about the same in amount without passing the designated working limit. Under such a case as this, in coming to apply the second shrinkage, which as computed would add about 9,600 pounds (4.3 tons) to the value of ρ_0, making it, say, 33,000 pounds in all, we should expect the second shrinkage to produce a considerably greater effect than anticipated, owing to the reduced resistance of the cast-iron to compression under a load so much exceeding what appears from the free test to be a proper (maximum) working limit, viz. 22,400 pounds.

Experience is needed in this connection, and whether the second shrinkage should be reduced for a casting known to have a high initial tension or whether both shrinkages should be modified can only be determined by definite observation of the measured initial tension of the castings in comparison with the observed effect of the shrinkages. It is considered highly probable that the overcompression in the case cited above might not be so great as the figures given would indicate, because the metal in shape of a cylinder probably has a higher elastic resistance than in a free specimen, gaining by reason of the presence of some of the conditions of cubic compression in the cylinder shape. Therefore, before applying any modification to the present shrinkages on this account, it will be necessary to observe their effect upon cast-iron bodies of which the initial tension is known, and obtain a measure of the modifications, if any, to be made by averaging results from several examples.

Pending the acquirement of this knowledge, however, it would appear best on the whole to adopt an initial tension of about 7,000 pounds as a suitable value, placing the limits at 6,000 to 8,000 pounds, to which it would be desirable to conform in their manufacture.

The computations for shrinkages, etc., are made by sections of the mortar for parts of similar dimensions, the intersecting plane for each section being indicated by its trace on the drawing. The chamber section is considered first, and to preserve uniformity of shrinkages those of the remaining sections are as far as practicable made the same.

The values taken to represent the physical qualities of the metal, which as regards the values of ρ_0 and θ are not to be exceeded, are as follows:

Cast-iron body.	*Steel hoops.*
$\theta_0 = 6.5$ tons (14,560 pounds).	$\theta_1 = 22.32$ tons (50,000 pounds).
$\rho_0 = 10.0$ tons (22,400 pounds).	$\theta_2 = 20.09$ tons (45,000 pounds).
$E_0 = 8036$ tons (18,000,000 pounds).	$E_1 = E_2 = 13{,}393$ tons (30,000,000 pounds).

The following table includes the principal formulæ to be applied in the computations, classified for each section taken. These have been reduced from those given in notes on the construction of Ordnance No. 35, by substituting the fixed values of the radii and also the values of the stated moduli for cast-iron and steel. They will permit the substitution of any suitable values for ρ and θ.

12-inch B. L. mortar.—Formulas reduced; having substituted values of radii and moduli of elasticity.

Equations numbered.	Section I.—Breech-recess.		Section II.
	Single hooping.	Double hooping.	Powder chamber.
(30) $P_2(^1)=$		(9.12729) θ_2.	(9.12729) θ_2.
$P_1(^1)=$	(9.12494) θ_1.	(9.12494) $\theta_1+(0.03699)\ P_2$.	(9.12494) $\theta_1+(0.03699)\ P_2$.
$P_0(^1)=$	(9.71674) $\theta_0+(0.12945)\ P_1$.	(9.71674) $\theta_0+(0.12945)\ P_1$.	(9.76953) $\theta_0+(0.14368)\ P_1$.
(33) $p_2=$t. $p_1=$		(9.63493) p_1.	(9.63493) p_1.
$p_1=$l. $p_0=$	(9.00835) p_0.	(9.20728) p_0.	(9.03043) p_0.
t.l. =		(8.84221.)	(8.66536)
(34) $P'_1=$	(9.58729) ρ_0.	(9.58729) ρ_0.	(9.62585) ρ_0.
(D) $P_0=$	(9.78091) $\theta_0+(0.19362)\ P'_1$.	(9.82304) $\theta_0+(0.23575)\ P'_1$.	(9.83976) $\theta_0+(0.31391)\ P'_1$.
(44) $\phi_1=$	(6.85488) P_1'.	(6.85488) $P'_1-(6.78518)P'_2$.	(6.83797) $P_1'-(6.78518)P'_2$.
$\phi_2=$		(6.82932) P'_2.	(6.81918) P'_2.
(39)$_a$ $P'_2=$		(0.06971) p'_1.	(0.05279) p'_1.
* $P''_1=$		(3.14512) ϕ_1.	(3.16203) ϕ_1.
(12) $\Delta R_0\div R_0=$	(6.50768) P'_1.	(6.50768) P''_1 or P'_1.	(6.46912) P''_1 or P'_1.

Equations numbered.	Section III. Between powder chamber and trunnion hoops.	Section IV. Trunnion hoop.
(30) $P_2(^1)=$	(9.12729) θ_2.	(9.19034) θ_2.
$P_1(^1)=$	(9.12494) $\theta_1+(0.03699)\ P_2$.	(9.12494) $\theta_1+(0.03699)\ P_2$.
$P_0(^1)=$	(9.77516) $\theta_0+(0.14527)\ P_1$.	(9.77316) $\theta_0+(0.14527)\ P_1$.
(33) $p_2=$t. $p_1=$	(9.63493) p_1.	(9.66667) p_1.
$p_1=$l. $p_0=$	(9.00630) p_0.	(9.02748) p_0.
t. l.=	(8.64143)	(8.69415)
(34) $P'_1=$	(9.62989) ρ_0.	(9.62989) ρ_0.
(D) $P_0=$	(9.84159) $\theta_0+(0.21170)\ P'_1$.	(9.84516) $\theta_0+(0.21527)\ P'_1$.
(44) $\phi_1=$	(6.83625) $P'_1-(6.78518)\ P'_2$.	(6.83625) $P'_1-(6.78515)\ P'_2$.
$\phi_2=$	(6.81811) P'_2.	(6.70534) P'_2
(39)$_a$ $P'_2=$	(0.05106) p'_1.	(0.05106) p'_1
* $P''_1=$	(3.16375) ϕ_1	(3.16375) ϕ_1.
(12) $\Delta R_0+R_0=$	(6.46508) P''_1 or P'_1.	(6.46508) P''_1 or P'_1.

Equations numbered.	Section V. Double hooping, chase.	Section VI. Single hooping, chase.
(30) $P_2(^1)=$	(9.07889) θ_2.	
$P_1(^1)=$	(9.12494) $\theta_1+(0.03699)\ P_2$.	(9.19099) θ_1.
$P_0(^1)=$	(9.77655) $\theta_0+(0.14567)\ P_1$.	(9.77655) $\theta_0+(0.14567)\ P_1$.
(33) $p_2=$t. $p_1=$	(9.60899) p_1.	
$p_1=$l. $p_0=$	(8.98498) p_0.	(8.84797) p_0.
t. l=	(8.59397)	
(34) $P'_1=$	(9.63087) ρ_0.	(9.63087) ρ_0.
(D) $P_0=$	(9.83958) $\theta_0+(0.20870)\ P'_1$.	(9.82160) $\theta_0+(0.19072)\ P'_1$.
(44) $\phi_1=$	(6.83583) $P'_1-(6.78518)\ P'_2$.	(6.77768) P'_1.
$\phi_2=$	(6.85920) P'_2.	
(39)$_a$ $P'_2=$	(0.05065) p'_1.	
* $P''_1=$	(3 16417) ϕ_1.	
(12) $\Delta R_0+R_0=$	(6.46410) P''_1 or P'_1.	(6.46410) P''_1 or P'_1.

NOTES.—The bracketed figures represent logarithms.

Equations (30) give the possible maximum values of the pressures to which the system, considered for the state of action alone, might be subjected. They contain no condition for safety of system at rest and may not be adopted at once. The values deduced from them are especially useful for reference and may not be exceeded.

Equation (33) gives the variations of pressures at the contact surfaces corresponding to a given variation of the pressure in the bore of gun.

Equation (34) gives the limiting value of the pressure to which the exterior of the tube may be subjected, taking ρ_0 equal the limit of compression of the metal. This equation also gives the value of pressure on exterior of tube or the increment of that pressure corresponding to any assumed value for ρ_0 or an increment of ρ_0, within limits.

Equation (D) gives the value of the resistance of the gun corresponding to the limit of tangential extension, system in action, and the amount of tangential compression, system at rest, due to the pressure P'_1, hence involves safety of gun for the two extreme states, etc., of the system.

Equations (44) give the relative values of the shrinkages.

Equation (39)$_a$ has been combined with (44) in the reduced forms given for 44.

Equation (39)$_a$ will be used to compute adjustments of second shrinkages if necessary. It enables the deduction of the pressure at the second contact surface corresponding to an increment of pressure at the first contact surface. This is an inversion of its true form which signifies the variation of pressure at the first contact surface corresponding to a given pressure or variation of pressure at the second contact surface.

*P''_1 is the pressure on exterior of tube due to the first shrinkage. It is derived from the first of equations (44), by making $P'_2=0$, solving with respect to P'_1 and calling this P''_1. The same is expressed by the symbol $\overline{P}$, page 36, note 35.

Equation (12) gives the relative value of the tangential compression of bore. The constant co-efficient of the second term is common for P''_1 and P'_1, first and second shrinkages.

The shrinkages will be arranged to follow closely those used in the construction of the experimental 12-inch B. L. mortar, model 1886, reported page 253, Report of the Chief of Ordnance, U. S. Army, 1887. It will be understood that this is entirely admissable, as there is a considerable range in the values which might be deduced or assigned for shrinkages * and in the light of experience no more suitable values can at present be assigned. The conditions of construction are explained in what follows:

SECTION II.—POWDER CHAMBER.

$$D_0=12.4; \quad D_1=31.5; \quad D_2=36.25; \quad D_3=41.75.$$

Substituting the θ values in (30), we obtain:

$$P_2=2.693; \quad P_1=5.909; \quad P_0=12.049 \text{ tons},$$

and with $\rho_0=10$ in (34): $P'_1=4.225$ tons.

We shall now assume the shrinkages: $\varphi_1=0.0015$ and $\varphi_2=0.00135$, whence $S_1=0''.047$ and $S_2=0''.0489$. Solving equations (44) with respect to P'_2 and P'_1, respectively.

$$P'_2=(3.18082)\ \varphi_2=2.047 \text{ tons.}$$
$$P_1'=(3.16203)\ \varphi_1+(9.94721)\ P'_2=2.178+1.813=3.991 \text{ tons.}$$

The latter of which when compared with the limiting value 4.225, is seen to be quite safe. Then substituting $\theta_0=6.5$ and $P'_1=3.991$ in (D) we obtain:

$$P_0=(9.83976)\ \theta_0+(0.21391)\ P'_1=4.494+6.531=11.025 \text{ tons.}$$

Then follow:

$$P_1=P'_1-p_2=P'_1+\ 1\ P_0=3.991+1.183=5.174 \text{ tons.}$$
$$P_2=P'_2-p_2=P'_2+tl\ P_0=2.047+0.51=2.557 \text{ tons.}$$

Which when compared with the maximum values from (30) are seen to be quite safe. It will be remarked that the value $P_0=11.025$ tons does not take into consideration the initial tension of the casting. If that be considered we should use an increased value for P'_1 in equation (D). Thus, suppose the initial tension at bore to be 7,000 pounds, or 3.1 tons, then from (34).

$$\text{Increment of } P_1'=(9.62585)\ 3.1=1.31 \text{ tons,}$$

and for substitution in (D) we will have: $P_1'=3.991+1.31=5.301$ tons; whence $P_0=4.494+8.675=13.169$ tons, or the resistance is 29,500

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* The mortar presents one of those cases (which also occur in guns made wholly of steel wherein the thickness of the tube in calibers is relatively small in comparison with the combined thickness of the cylinders which encompass it), in which to state generally the resistance of the inner cylinder (or tube) to compression, is less than the combined exterior cylinders could fairly exert. This is expressed by the relation $P_1+p_1=P_1-l\ P_0 > P'_1$ from equation (34), in which P_1 and P_0 are taken from equations (30). When this condition occurs the way is open to a considerable latitude in the adjustment of shrinkage values, whilst retaining a single value for P_0 to be derived from equation (D). It follows, as a consequence, however, that this value of P_0 is less than *the value first derived* from equations (30).

pounds per square inch, and the total of ρ_0 or the apparent tangential compression of bore, becomes 12.55 tons, nearly.

Compression of bore due to shrinkage.

First shrinkage:

$$P_1'' = (3.16203)\ \varphi_1 = 2.178 \text{ tons, relative.}$$

$$\frac{\Delta R_0}{R_0} = (6.46912)\ P_1'' = 0.00064156, \text{ which} \times D_0 = 0.''00795$$

absolute, which corresponds to the partial value $\rho_0 = 5.156$ tons.

Second shrinkage:

$$P_1' = 3.991 \text{ tons, relative.}$$

$$\frac{\Delta R_0}{R_0} = (6.46912)\ P_1' = 0.0011754; \text{ which} \times D_0 = 0.''01457$$

absolute, which corresponds to the value $\rho_0 = 9.446$ tons.

In order to readily determine a new value for the second shrinkage in case the first does not produce the compression of bore anticipated, or considered desirable, within reasonable limits, we may deduce an equation expressing the value of φ_2 directly in terms of the compression of bore to be produced by it, or in terms of the increase of such compression which it is desired the second shrinkage shall produce, as follows:

In equation (34), if we place $\rho_0 = E_0 i$, and write p_1' for P_1', we have $p_1' = (9.62585)\ E_0 i$, in which p_1' represents the pressure, or rather the increment of pressure, needed on exterior of tube to produce at the bore the increment of tangential compression represented by the relative value i.

Equation (39)*a* gives P_2' in terms of this p_1', and the second of (44) gives φ_2 in terms of P_2'. These two equations are:

$$P_2' = (0.05279) p_1' \text{ and } \varphi_2 = (6.81918) P_2'.$$

To generalize, resume the three equations and write,

$$\varphi_2 = aP_2'; \quad P_2' = bp'_1 \quad \text{and } p'_1 = cE_0 i.$$

Combining these and writing φ'_2 for φ_2 we have

$$\varphi'_2 = abcE^0 i \ldots\ldots (44)a.$$

Substituting the particular values for a b and c, as precedes, and also the value of E_0 we have

$$\varphi_2' = (0.40285) i$$

Or, expressed in numbers, the relative value of the second shrinkage will be about 2.53 times the relative tangential compression of the bore which is sought to be produced by it for this particular example.

Suppose in this case the measured compression of bore due to the first shrinkage, was found to be $0''.0095$, absolute value, instead of $0''.00795$ anticipated. The total compression is to be $0''.01457$ then, that left to be produced by the second shrinkage would be:

$$0.01457 - 0.0095 = 0''.00507, \text{ absolute.}$$

Which, divided by $12''.4$, gives the relative value $i=0.00040887$; hence we have:

$$\varphi'_2=(0.40285)0.00040887=0.0010338,$$

and $S_2=\varphi'_2\times D_2=0''.0375$, or the value is decreased $0.0489-0.0375=0''.0114$. This may be considered about the maximum diminution of the second shrinkage that it would be desirable to make.

The preceding method of deducing a correction for the second shrinkage will apply whether the lack of agreement between the actual and the anticipated compression of bore from the first shrinkage is due to a departure from the prescribed value of that shrinkage or to the nature of the cast-iron, *i. e.*, its modulus.

If, however, the first shrinkage as actually applied differs from the prescribed value, the change in compression of bore due to such change in the shrinkage must be first estimated and eliminated from the result in order to consider its bearing upon the modulus of the cast-iron.

SECTION I.—BREECH-RECESS.

The breech-recess is covered in part by two layers of hoops and in part by one layer. In order to provide what is deemed a proper initial compression at the interior of the recess in the state of rest and not cause too great a distortion at its forward end when the adjoining metal is carried outward, to a greater extent than in this section, by the greater dilitation of the bore in front of the gas check, due to the higher pressure in the powder chamber in the state of action, we have the comparatively light shrinkages, assumed as before, viz:

$\varphi_1=0.00095$; $\varphi_2=0.00052$; and $S_1=0''.030$; $S_2=0.019$.

Single hooping: $D_0=15.0$; $D_1=31.5$; $D_2=36.25$.

From (30): $P_1=2.976$ and $P_0=7.396$ tons.

Limiting value (34) $P'_1=3.866$ tons.

From (44): $0.00095=\varphi_1=(6.85488)P_1'$:

Whence $P_1'=1.327$ tons, and the compression of bore due to the application of the first layer of hoops will be:

relative, $\frac{\Delta R_0}{R_0}=(6.50768)P_1'=0.0004271$; which × 15.0=$0''.0064$ absolute.

Double hooping:

$$D_0=15.0;\ D_1=31.5;\ D_2=36.25;\ D_3=41.75.$$

From (30):

$$P_2=2.693;\ P_1=5.909,\ \text{and}\ P_0=11.347\ \text{tons.}$$

Solving equations (44) with reference to P_2' and P_1' and substituting [illegible] given shrinkages:

[illegible] $=0.77$ tons.

[illegible] $1.327+0.656=1.983$ tons.

For tangential compression of the interior:

Relative, $\frac{\Delta R_0}{R_0}$ = (6.50768) P_1'=0.0006383; which × 15.=0''.0095 absolute.

Substituting $P_1'=1.983$ with $\theta_0=6.5$ in (D) we obtain:
P_0 =(9.82304 θ_0+(0.23575) P_1'=4.325+3.412=7.737 tons.

Then follow:

$$P_1=P_1'+l\,P_0=1.983+1.247=3.23 \text{ tons.}$$
$$P_2=P_2'+tl\,P_0=0.77+0.538=1.308 \text{ tons.}$$

Remarking that the relative tangential compression of bore in the powder-chamber for the state of rest is, as previously found, 0.0011754, and in this section is 0.0006383, we have the difference, as shown by curve on drawing, equal to 0.0005371 as an indication of the distortion produced by the shrinkages about the front of the breech recess for the state of rest. Neglecting the initial tension of the cast-iron, the bore of chamber will be dilated to +0.00080887 (corresponding to $\theta_0=6.5$ tons) by the pressure of 11.025 tons in the state of action. Then, if we were to assume that the interior of breech recess is not dilated in this state, the sum 0.0006383+0.00080887=0.00144717 would indicate the distortion. In reality, however, it can not be so great as this, since the pressure on the threads of the breech-screw when the piece is fired creates a radial component of pressure in the breech recess which tends to dilate that portion at the same time with the bore of chamber.

SECTION III, BETWEEN POWDER CHAMBER AND TRUNNION HOOPS.

$$D_0=12.08;\ D_1=31.5;\ D_2=36.25;\ D_3=41.75.$$

From (30):

$$P_2=2.693;\ P_1=5.909, \text{ and } P_0=12.329 \text{ tons.}$$

From (34):

$$P'_1=(9.62989)\times 10=4.265 \text{ tons.}$$

Assuming the shrinkages $\varphi_1=0.0015$; $\varphi_2=0.00135$, and transposing equations (44), we find:

$$P_2'=(3.18189)\ \varphi_2=2.052 \text{ tons.}$$
$$P_1'=(3.16375)\ \varphi_1+(9.94893)\ P_2'=2.187+1.825=4.012 \text{ tons.}$$

Substituting $\theta_0=6.5$ and $P_1'=4.012$ in (D) we obtain:

$$P_0=(9.84159)\ \theta_0+(0.21170)\ P_1'=4.513+6.532=11.045 \text{ tons.}$$

Then:

$$P_1=P_1'+lP_0=4.012+1.121=5.133 \text{ tons,}$$
$$P_2=P_2'+tlP_0=2.052+0.484=2.536 \text{ tons,}$$

all of which are seen to be within the maximum limits.

Compression of bore due to shrinkages.

First shrinkage:

$$P_1'' = (3.10375)\,\varphi_1 = 2.187 \text{ tons.}$$

$$\frac{\Delta R_0}{R_0} = (0.40508)\,P_1'' = 0.00063815; \text{ which} \times 12.08 = 0.0077 \text{ absolute.}$$

Second shrinkage:

$$P_1' = 4.012.$$

$$\frac{\Delta R_0}{R_0} = (0.40508)\,P_1' = 0.001171; \text{ which} \times 12.08 = 0.0141 \text{ absolute.}$$

SECTION IV.—TRUNNION HOOP.

$$D_0 = 12.08;\ D_1 = 31.5;\ D_2 = 36.25;\ D_3 = 42.75.$$

From (30):

$$P_2 = 3.114;\ P_1 = 6.367, \text{ and } P_0 = 12.769 \text{ tons.}$$

From (31):

$$P_1 = 4.265 \text{ tons.}$$

In order that there shall not be a greater compression of bore in this section, with its heavy trunnion hoop, than in the one which precedes it, we shall make it a condition of the solution that the two shall be equal, and at the same time retain the uniform value for the first shrinkage.

We have then:

$$\frac{\Delta R_0}{R_0} = 0.001171 \text{ and } \varphi_1 = 0.0013.$$

Since the thickness of cast-iron body is the same in this section as in III., it follows that the value P₁′, to be obtained by inverting equation (12), will be the same, viz:

$$P_1' = [illegible]\,\frac{\Delta R_0}{R_0} = 4.012 \text{ tons.}$$

The part of P₁′ that is P₁″, obtained by the first shrinkage, is given by the equation

$$P_1'' = [illegible]\,\varphi_1 = 2.187 \text{ tons.}$$

The difference between this and the total P₁′ gives the increment of pressure on the first contact surface which will be induced by the second shrinkage. Hence

$$P_1' - P_1'' = p_2 = 4.012 - 2.187 = 1.825.$$

Then from (39)*a*:

$$P_2'=(0.05106)\ p_1'=2.052 \text{ tons.}$$

The second shrinkage from (44) becomes:

$$\varphi_2=(6.76534)\ P_2'=0.001196$$

and

$$S_2=0.''0433.$$

Substituting $\theta_0=6.5$ and $P_1'=4.012$ in the equation (D) for this section, we find:

$$P_0=(9.84516)\ \theta_0+(0.21527)\ P_1'=4.551+6.586=11.137 \text{ tons.}$$

Then:

$$P_1=P_1'+l P_0=4.012+1.186=5.198 \text{ tons.}$$

$$P_2=P_2'+t l P_0=2.052+0.551=2.603 \text{ tons.}$$

The tangential compression of bore due to the first and second shrinkages will evidently be the same as for section III.

SECTION V.—DOUBLE HOOPING IN FRONT OF TRUNNION HOOP.

$$D_0=12.0;\ D_1=31.5;\ D_2=36.25;\ D_3=41.10.$$

From (30):

$$P_2=2.409;\ P_1=5.599, \text{ and } P_0=11.716 \text{ tons.}$$

From (34):

$$P_1'=4.274 \text{ tons.}$$

The compression of bore should decrease as we near the end of the hooping, and this will be brought about uniformly and in conformity with the decreased thickness of hooping by using the same shrinkages in this section as in the preceding one. Then we assume:

$$\varphi_1=0.0015;\ \varphi_2=0.001196:\ S_1=0''.047;\ S_2=0''.0433.$$

With these values, by transposing equation (44), we find:

$$P_2'=(3.14080)\ \varphi_2=1.654 \text{ tons.}$$

$$P_1'=(3.16417)\ \varphi_1+(9.94935)\ P_2'=2.189+1.472=3.661 \text{ tons.}$$

Substituting $\theta_0=6.5$ and $P_1'=3.661$ in equation (D), we obtain:

$$P_0=(9.83958)\ \theta_0+(0.20870)\ P_1'=4.493+5.92=10.413 \text{ tons.}$$

Then:

$$P_1 = P_1' + l\,P_0 = 3.661 + 1.006 = 4.667 \text{ tons.}$$

$$P_2 = P_2' + tl\,P_0 = 1.654 + 0.409 = 2.063 \text{ tons.}$$

Compression of bore due to shrinkages.

First shrinkage:

$$P_1'' = (3.16417)\ \varphi_1 = 2.189 \text{ tons.}$$

$$\frac{\Delta R_0}{R_0} = (6.46410)\ P_1'' = 0.00063732;\ \text{which} \times 12. = 0''.00765 \text{ absolute.}$$

Second shrinkage:

$$P_1' = 3.661 \text{ tons.}$$

$$\frac{\Delta R_0}{R_0} = (6.46410)\ P_1' = 0.001066;\ \text{which} \times 12. = 0''.0128 \text{ absolute.}$$

SECTION VI.—FORWARD HOOP, SINGLE.

$$D_0 = 12.0;\ D_1 = 31.5;\ D_2 = 37.25.$$

From (30):

$$P_1 = 3.513 \text{ and } P_0 = 8.799 \text{ tons.}$$

From (34):

$$P_1' = 4.274 \text{ tons.}$$

Carrying forward the same shrinkage,

$$\varphi_1 = 0.0015,\ S_1 = 0.047,$$

we have, by inverting equation (44),

$$P_1' = (3.22212)\ \varphi_1 = 2.502 \text{ tons.}$$

Substituting $\theta_0 = 6.5$ and $P_1' = 2.502$ in equation (D), we obtain:

$$P_0 = (9\ 82160)\ \theta_0 + (0.19072)\ P_1' = 4.31 + 3.881 = 8.191 \text{ tons.}$$

Then:

$$P_1 = P_1' + l\,P_0 = 2.502 + 0.578 = 3.080 \text{ tons.}$$

For the compression of bore:

$$P'_1 = 2.50 \text{ tons.}$$

$$\frac{\Delta R_0}{R_0} = (6.46410)\ P_1' = 0.0007283;\ \text{which} \times 12. = 0''.00874 \text{ absolute.}$$

›wing table gives the shrinkages, to be applied with allowed , which in each case amount to 0.003 of an inch :

ıkages for 12-inch B. L. rifled mortar.—Cast-iron, hooped with steel.

[Type mortar, model 1886, weight 14.25 tons.]

nated.	Diameter of hoops (interior).*	Computed shrinkage.		Allowed variations.	Prescribed diameters of underlying zone.		Remarks.
		Relative.	Absolute.		Maximum.	Minimum.	
	Inches.	*Thousandths.*	*Inches*	*Inches.*	*Inches.*	*Inches.*	
half.....	31.5	1.500	0.047	−0.003 +0.002 −0.001	31.547	31.544	Work nearest to the minimum value in forward half and maximum value in rear half. Join the two zones by a conical surface about 2 inches long.
'........	31.5	1.500	0.047				
₅, and	31.5	1.500	0.047	−0.001 +0.002	31.549	31.546	Work nearest to the maximum value.
d A_7....	31.5	0.950	0.030	−0.002 +0.001	31.531	31.528	Do.
....	36.25	1.196	0.043	−0.002 +0.001	36.294	36.291	Work nearest to the minimum value. Join this with the following zone by a conical surface about 2 inches long under the forward end of B_3.
t of B_3..	36.25	1.350	0.049	−0.002 +0.001	36.300	36.297	Work nearest to the minimum value.
B_8......	36.25	0.520	0.019	−0.001 +0.002	36.271	36.268	Do.

›d that the hoops will be finished bored before the shrinkage surfaces are turned. ations from these diameters occur in boring the hoops, the same must be applied with letermine the corrected values for diameters of underlying zones, as given in the fifth uns.

greater zone (diam. 31″.549), under hoops A_2–A_6, and the lesser (diam. 31″.531), under ill be joined by a straight taper or conical surface 2.5 inches in length. This taper (reducge) will begin 17 inches from the rear face of cast-iron body and end at 14.5 inches ying just forward of the middle of hoop A_6 in place. In addition to this, the shrinkage oop A_7 will be increased 0.005 of an inch by a straight taper or conical surface increasneter of 31.531 inches at 2 inches from rear face of cast-iron body to 31.536 inches at the ıo cone being 2 inches long (allowed variations being understood—that is, —0.003 of ɘ diameters given in this note).

zone (diam. 36″.297) under hoops B_3–B_8 and the lesser (diam. 36.268) under hoops oined by a straight taper or conical surface 3 inches in length. This taper (reducge) will begin 20 inches from the rear face of cast-iron body and end at 17 inches from ; about under the middle portion of hoop B_8 in place. In addition to this, the shrinkage oop B_8 will be increased 0.005 of an inch by a straight taper or conical surface increase eter of 36.268 inches at 2 inches from rear to 36.273 inches under extreme rear of hoop ne being 2 inches long (allowed variations being understood—that is, +0.003 of an inch given in this note).

n is particularly invited to the provision that whatever from prescribed diameters are made in boring the hoops the be applied with sign to the diameters for turning stated in o columns, in order that the prescribed shrinkages shall be ith allowed variations only) whatever small differences may ring the hoops. The underlying surface for about 2″.0 at ıd of each row of hoops is slightly coned to oppose any tenslipping in service. And where two different shrinkage occur in the same row, they are joined by turning conical sur'en length, in order not to make the change too abrupt. The diameters, qualified as just stated, are shown on the plate ılso the curves of compression of bore anticipated for the cond shrinkages. These are given in relative values, which, pplied, should be multiplied by the actual diameter of bore nortar is hooped, in order to get an exact compression beal and anticipated absolute compressions.

The plate also shows the curve of elastic resistance computed to include an initial tension of 7,000 pounds, or 3.125 tons, per square inch at the bore, as explained under Section II, powder-chamber. Substituting this initial tension for ρ_0 in the tabulated equation (34) for value of P_1', adding this to the value for P_1' due to the shrinkages alone, and then deducing the value of P_0 from equation (D), we find:

Section I.—Single hooping:

$$P_1'=1.327+1.208=2.535 \text{ tons.}$$
$$P_0=3.925+3.96=7.885 \text{ tons.}$$

Section I.—Double hooping:

$$P_1'=1.983+1.208=3.191 \text{ tons.}$$
$$P_0=4.325+5.491=9.816 \text{ tons.}$$

Section II.—Powder chamber:

$$P_1'=3.991+1.31=5.301 \text{ tons.}$$
$$P_0=4.494+8.675=13.169 \text{ tons.}$$

Section III:

$$P_1'=4.012+1.333=5.345 \text{ tons.}$$
$$P_0=4.513+8.703=13.216 \text{ tons.}$$

Section IV.—Trunnion hoop:

$$P_1'=4.012+1.333=5.345 \text{ tons.}$$
$$P_0=4.551+8.774=13.325 \text{ tons.}$$

Section V:

$$P_1'=3.661+1.336=4.997 \text{ tons.}$$
$$P_0=4.493+8.08=12.573 \text{ tons.}$$

Section VI. (Single hooping):

$$P_1'=2.502+1.336=3.838 \text{ tons.}$$
$$P_0=4.31+5.954=10.264 \text{ tons.}$$

The elastic resistance along the chase of the mortar where there is no hooping is obtained for any section by the formula,

$$P_0=\frac{3(R_1^2-R_0^2)}{4R_1^2+2R_0^2}(\theta+\rho)$$

in which ρ represents the initial tension at the bore. We have $\theta=6.5$ and $\rho=3.125$ approximately, and may therefore call $\theta+\rho=10$ tons. Then the elastic resistance at the base and muzzle end, respectively, of the chase frustum will be:

At base $P_0=(9.78277)\times 10=6.06$ tons.
At muzzle $P_0=(9.67194)\times 10=4.70$ tons.

The longitudinal strength of the mortar is based on the relative areas of cross-section of powder chamber and of the cast-iron body in a plane cutting the breech recess in front of threads. These areas are, respectively, 121 and 603 square inches. And on the assumption that the longitudinal strain due to firing will be uniformly distributed throughout the cross-section of the body, the direct longitudinal strain estimated per square inch will be equivalent to that due to about one-fifth of the pressure per square inch in the powder chamber when the mortar is fired.

R. Birnie, Jr.
Captain, Ordnance Department, U. S. Army.

Ordnance Office, War Department.
Washington, October 1, 1889.

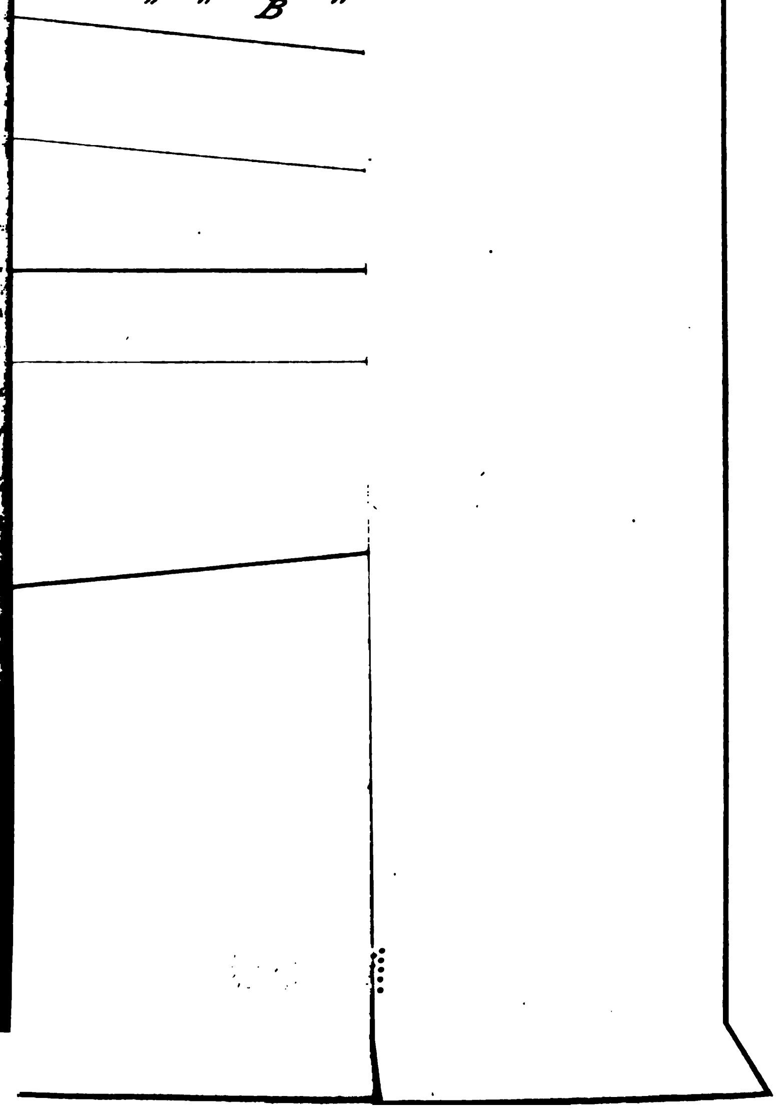
PLATE I.

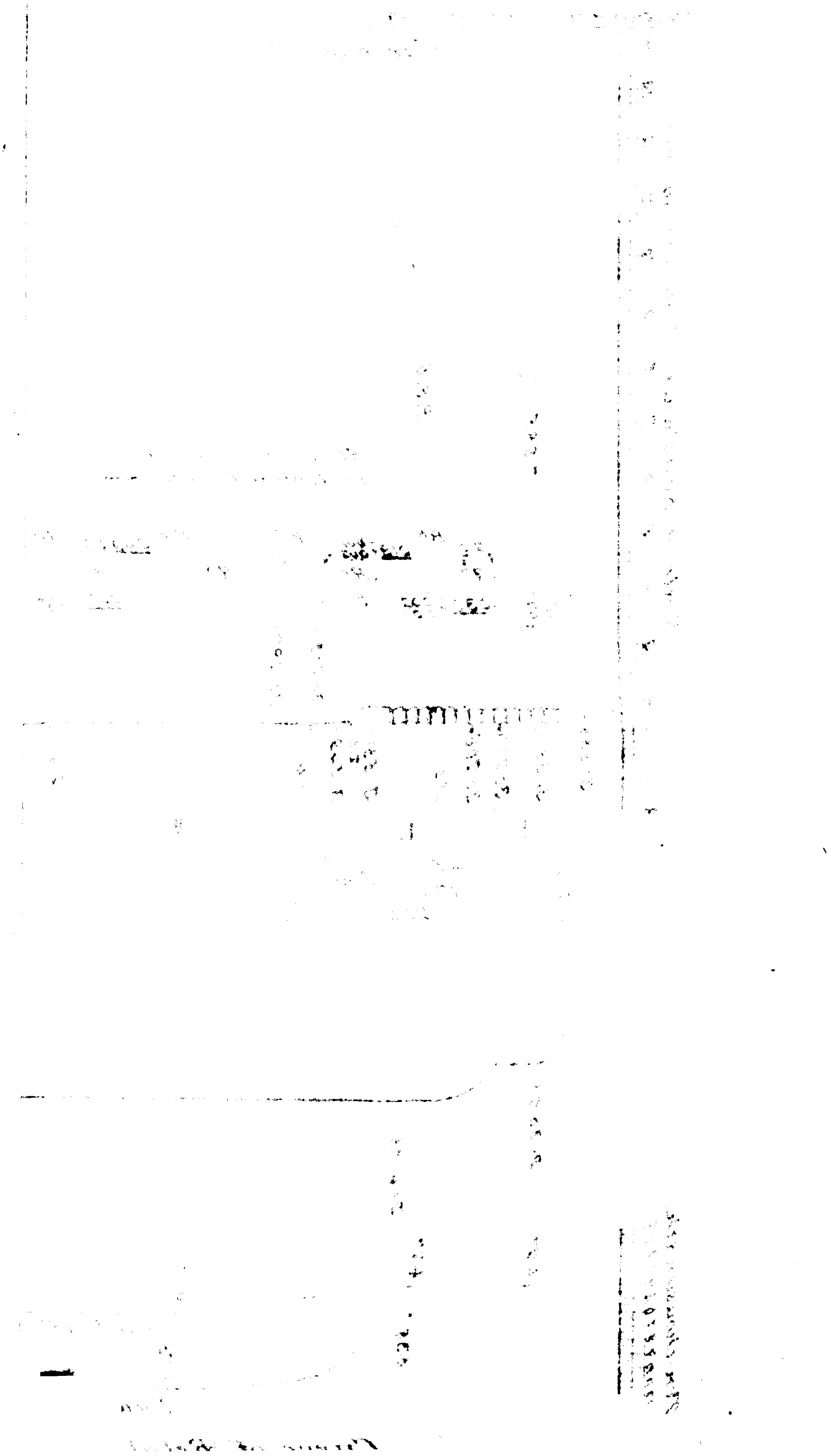
.MORTAR. 14¼ TONS.

AST IRON BODY, S

ELASTIC RESISTANCE A RE.

kage diameters given
to finished interior
for hoops as follows
For all A hoop
" " B "





APPENDIX 18.

REPORT ON THE MANUFACTURE OF THE MIDVALE STEEL FORGINGS FOR GUN CONSTRUCTION.

OFFICE OF THE INSPECTOR OF ORDNANCE, U. S. ARMY,
MIDVALE STEEL WORKS,
Philadelphia, Pa., August 29, 1889.

SIR: In compliance with your instructions I have the honor to submit the following report of the nature and progress of the work done for the Ordnance Department by the Midvale Steel Company during the fiscal year ending June 30, 1889.*

During this period this company has undertaken the following orders and contracts:

(1) 5 forged steel bars.
(2) 1 steel forging for 12-inch B. L. mortar gas-check cup.
(3) 1 steel forging for 10-inch B. L. rifle hoop C_3.
(4) 25 sets of steel forgings for 3.2-inch field guns.
(5) 30 sets of steel forgings for 12-inch B. L. R. mortars.
(6) Steel forgings for part of a set of hoops and for breech mechanism for 12-inch B. L. rifle.
(7) Steel forgings for 2 hoops and part of breech mechanism for 12-inch B. L. mortar.
(8) 1 set of steel forgings for 3.6-inch field gun, and 1 set for 3.6-inch field mortar.
(9) 1 steel forging for 10-inch B. L. rifle-hoop D_1.
(10) 1 ring of tire steel.
(11) 40 tensile test specimens for comparative test of the Midvale testing-machine with the United States testing-machine at Watertown Arsenal.
(12) Steel forgings for 1 set each of gas-check cups for 8-inch, 10-inch, and 12-inch guns.
(13) Steel forgings for 27 gas-check cups for 3.2-inch field guns.
(14) 1 steel forging for 10-inch B. L. rifle-hoop C_7.
(15) Steel forgings for 1 set each of gas-check cups for 5-inch siege gun and 7-inch siege howitzer.

At this date those numbered 1, 2, 3, 7, 8, 9, 10, 11, 13, 14, and 15 have been completed; the others are still in hand.

Five forged steel bars.

These bars, each 4 feet long and 4¼ inches in diameter, were ordered November 14, 1888, for experimental purposes, and were desired to possess about the same physical qualities as tubes for cannon. To this end they were required to show in two longitudinal 3-inch specimens properties at least as high as the following: Elastic limit, 44,000 pounds per square inch; tensile strength, 80,000 pounds per square inch; and elongation after rupture, 20 per cent.; and it was requested that the elastic limit should not be greatly above 44,000.

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* Nearly all information relating to the manufacture is omitted in this report, as the Midvale Steel Company desire that all details of this nature shall be considered confidential and for the use of the Department only.

Five bars were forged from a billet that had been intended for a 3.2-inch gun tube but not used. They were oil-tempered and then annealed and tested several times in the endeavor to reduce the elastic limit to the desired point. Finally, the metal allowed for testing was exhausted, and one of these bars was taken to be cut up for testing to represent the other four, and a new bar forged to replace it, with metal on it for testing. All the bars were then oil-tempered and annealed, and were accepted on the following results of tests:

	Marks.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
Old bar	SB2 L5M	46,339	82,781	26.47	62.0
New bar	SB3 L1M	45,439	80,981	27.73	61.8

After testing it was found that some of the bars had warped during treatment, so that they would not finish to the desired size. All were accordingly heated together to about 900° Fah. (the temperature of annealing was 1,200° Fah.) and the warped bars were straightened in a press; they were then all buried in ashes and allowed to cool. It is believed that the temperature at which the straightening was done was not so high as to affect the properties of the metal and yet was sufficiently high to prevent the production of strains under the small amount of flexure produced, which was not more than one-eighth inch in 4 feet length.

Steel forging for gas-check cup for 12-inch B. L. mortar.

This piece was accepted without testing. It was ordered November 14, 1888, and forged, oil-tempered, and annealed in the manner previously employed for similar forgings from the same heat of metal.

Steel forging for 10-inch B. L. rifle hoop C_3.

This hoop was required to show the following properties in 6-inch specimens: Elastic limit, 55,000 pounds per square inch; tensile strength, 100,000 pounds per square inch; elongation after rupture, 12 per cent.

The order was given December 1, 1888, but the forging first made failed to show the required physical qualities on testing, and had to be replaced by another forging, thus causing considerable delay, so that the hoop was not ready for delivery till February 22, 1889.

The second forging was made and treated in the usual manner and accepted on the following results of test of 6-inch specimens:

Position.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
T50	56,930	107,592	12.76	41.07
T6I	56,787	107,525	12.63	38.92
T7M	56,689	107,975	13.76	40.85

Steel forgings for two hoops and part of breech mechanism for 12-*inch B. L. mortar.*

These forgings were ordered January 24, 1889, and were to be delivered by March 15. All were delivered by that time.

The hoops were those designated as A_7 and B_6; their dimensions are given below:

	A_7.	B_6.
	Inches.	*Inches.*
Outside diameter	36⅛	42
Inside diameter	31⅛	36
Length	9⅞	12¼

and they were required to show the following physical qualities in 4-inch specimens:

	Pounds.
Elastic limit, 53,000 pounds per square inch; no specimen to be below	50,000
Tensile strength, 93,000 pounds per square inch; no specimen to be below	90,000
	Per cent.
Elongation after rupture, 13 per cent.; no specimen to be below	12

and only one specimen to be below the values first given. They were forged and rolled and treated in the usual manner, and accepted on the following results of tests:

Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
58,727	102,212	22.12	52.65
62,314	104,006	18.50	51.20
54,244	101,764	21.50	48.94

The parts of breech mechanism required were the breech-block, spindle, face-plate, hinge-pin, translating roller, and pinion. These pieces are described in the report of the inspector at this place for 1886. Their manufacture and testing call for no special remark.

Forgings for 3.6-*inch field gun and* 3.6-*inch field mortar.*

The contract for these forgings was dated February 8, 1889, and they were to be delivered by June 9. All the pieces were delivered within a few days of that time, except the sleeve, locking-ring, and breech-blocks. The first forgings for these pieces were not successful, and were replaced by new ones, and all were delivered by July 26, 1889, within the time allowed by the contract for replacing not accepted or rejected forgings.

The most noteworthy point in respect to this contract is, that the jacket was made with the trunnions on it and with a small bore at the breech-end, so that it combines in one piece the jacket, trunnion-hoop, and base-ring of the similar 3.2-inch field-gun, and that the mortar-

as made in a single piece, including the trunnions. The princi-
mensions of the more important parts are as follows:

e
gth, [illegible] inches.
meter, [illegible] inches for [illegible] inches from muzzle, and [illegible] inches for [illegible] inches from
ech.
, [illegible] inches.

gth, [illegible] inches.
meter, [illegible] inches.
, [illegible] inches for [illegible] inches from muzzle end, and 4 inches for [illegible] inches from
ech.
body
gth, [illegible] inches.
meter, [illegible] inches, with chase tapering to [illegible] inches at the muzzle.
, [illegible] inches.

he parts except the jacket and mortar body were manufactured
anner similar to that employed for the corresponding parts of the [illegible] field guns, described in former reports of the inspector at this [illegible]. The jacket was made from a square ingot which was first forged [illegible] angular cross-section, one edge of which was parallel and equal [illegible] the axis of the trunnions and the other equal in length to [illegible] of the jacket body. It was then placed on edge and set [illegible] each side of the trunnion masses and punched, and the trunnions were somewhat tapered on the broader sides of the forging. By [illegible] the piece is brought fairly close to shape at the forge. [illegible] was machined before treatment and the subsequent ma[illegible] was not attended by any incident worthy of note.
mortar body was made in the same manner as the jacket, and no [illegible] was experienced in its manufacture. Owing to the small size [illegible] the tensile tests were made only at the breech.
[illegible] qualities that the principal parts are required to show in [illegible] specimens and those obtained are shown below, the [illegible] qualities being given in the first line in each case.

Piece.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
	Pounds.	Pounds.	Per cent.	Per cent.
Tube	[illegible]	[illegible]	[illegible]	[illegible]
Breech	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Muzzle	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Jacket	[illegible]	[illegible]	[illegible]	[illegible]
Breech	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Muzzle	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Mortar body	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Dimensions of the forging were:

	Inches.
Diameter	[illegible]
Diameter	[illegible]
[illegible]	[illegible]

The physical qualities required are the same as those given above for 12-inch B. L. mortar hoops. This hoop was ordered February 21, 1889, and was delivered in a little less than two months. It was manufactured in the usual manner, and was accepted on the following results of tests of 4-inch specimens:

Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
53,060	98,769	16.45	36.76
52,000	97,729	20.25	44.28
57,000	100,869	18.65	43.75

Ring of tire steel.

This piece was not required to be tested. Its dimensions were:

	Inches.
Length	8
Outside diameter	33
Inside diameter	29

It was ordered March 18, 1889, and was forged and rolled in the manner employed for tires.

Specimens for comparing the Midvale Steel Company's new Riehle testing machine with the United States testing machine at Watertown Arsenal.

The object of this comparison was to ascertain whether the company's new testing machine could be relied on in making tests for the acceptance of material manufactured for the Ordnance Department. For this purpose forty specimens (ten sets of four specimens each) were made and half of each set were tested on each machine. Four kinds of steel were employed, the physical qualities desired and aimed at being selected so as to represent the kinds of metal most used in gun construction. They were designated as being such as to give in 3-inch specimens the results in the following table, which shows also the number and sizes of the specimens taken from each kind of metal:

Elastic limit per sq. in.	Tensile strength per sq. in.	Elongation after rupture.	Number of specimens.
Pounds.	*Pounds.*	*Per cent.*	
40,000	75,000	20	4 2-inch and 4 3-inch.
46,000	86,000	18	4 2-inch, 4 3-inch, and 4 4-inch.
53,000	93,000	15	Do.
70,000	125,000	10	4 2-inch and 4 3-inch.

A square bar of 2½ inches edge was forged from each kind of metal, annealed, oil-tempered and annealed. The bars were then cut apart along median longitudinal lines, making 4-inch square strips from each, and the specimens were turned from these strips, taking them so that the four specimens of each set lay side by side in their original positions in the bars.

It was expected to obtain by this method very uniform results throughout each kind of metal, and particularly among the specimens of each set, and the result justified this expectation, as will be seen from the following table, which gives the mean of the variations of the specimens of each pair tested at Watertown from the mean of the pair:

Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
650	285	0.38	0.69

Similar results were obtained on the Midvale machine.

The result of this comparison was that the Midvale Company's testing machine was accepted by the Department for determining all the elements of tests for the acceptance of material except the modulus of elasticity.

The micrometer apparatus employed to measure the elongations did not work entirely satisfactorily, but the company has ordered a new one, and expects that with it the machine will prove acceptable for determining all the elements of these tests.

Forgings for gas-check cups for 5-inch siege gun and 7-inch siege howitzer.

These forgings were ordered June 8, 1889, and finished June 27. No difficulty was experienced in obtaining the physical qualities required, which, together with those obtained, are given below:

	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.
	Pounds.	*Pounds.*	*Per cent.*
Required	70,000	125,000	12.0
Obtained	71,000	128,750	14.7

Forgings for 27 gas-check cups for 3.2-inch field guns.

These forgings were ordered May 5, 1889, and they were promised for delivery in three weeks. Some difficulty in fulfilling the requirements as to physical qualities was met with, however, and they had not been delivered at the end of the fiscal year.

Forging for 10-inch B. L. rifle hoop C_7.

This forging was ordered May 31, 1889, and was to be delivered by July 31, 1889. It had been forged on June 10, and by June 20 was ready for testing. The first tests were not successful, however, and it had not been finally tested at the end of the year.

Forgings for gas-check cups for 8-inch, 10-inch, and 12-inch guns.

These forgings were ordered April 23, 1889, and they were to be treated with and accepted on the tests of a number of 12-inch mortar as-check cups for which the company was under contract at the time.

Much difficulty has been experienced in obtaining the required physical qualities, and at the end of the year they were still under treatment.

Twenty-five sets of steel forgings for 3.2-inch field guns.

The contract for these forgings is dated December 22, 1888, and they were to be delivered in six months. The company requested, however, that the time of delivery might be reckoned from January 14, 1889, the date of signing the contracts, and the request was granted. Accordingly the forgings were not due till July 14, 1889, but at the end of the fiscal year 14 jackets, 1 trunnion hoop, 10 sleeves, and some minor parts had been delivered. These forgings are entirely similar to those for guns of the same caliber hitherto furnished by this company, and the methods of manufacture are the same as those hitherto employed. The physical requirements are somewhat different, but I design to report on this subject after the forgings are all tested.

Thirty sets of steel forgings for 12-inch B. L. R. mortars.

This contract is dated January 7, 1889, and all the forgings are to be delivered by February 6, 1891, the first set being delivered in one hundred and twenty days, 5 more at intervals of forty days, and after that 1 set every twenty days. The company requested that the time might be counted from January 14, 1889, the date of signing the contract, and the request was granted for the first 5 sets. Under these conditions 2 sets became due before June 30, neither of which was completed. All the forgings of the first set had been delivered except the trunnion hoop, the first forging for which was rejected. At this date the replacing forging has been made.

Of the second set only a part of the breech mechanism had been delivered at the time the set was due. This delay has occurred partly from press of work resulting from the considerable amount of work for the Department that the company has had on hand, and they state that when the other contracts are out of the way they expect to push work under this one, and deliver the sets even faster than the contract requires.

The manufacture of these forgings is conducted in the same manner as that heretofore employed for similar work. The cylindrical hoops are rolled. The company made the first trunnion hoop by casting it in general shape and then forging it into final shape on a loose mandrel. By this method certain parts of the piece received very little forging "work" and these parts failed in testing. The hoop was rejected, and the Department having expressed disapproval of this method of fabrication, the manufacturers decided to forge these hoops from square ingots in future, although expressing their opinion that the method is a practicable one for obtaining the qualities required.

No complete set having been finished at the end of the year, a more complete description of the dimensions of the forgings and the physical qualities required and obtained is reserved for the present.

Forgings for hoops and breech mechanism for a 12-inch B. L. steel rifle.

This lot includes all the hoops, with the exception of hoop A′ and the trunnion hoop, and the breech mechanism. The contract is dated January 24, 1889, and the forgings were to be delivered by August 15, 1889. The only pieces that had been finished at the end of the year were four of the larger hoops. They were punched and reamed out and then forged on a loose mandrel, and their manufacture was not attended with serious difficulty.

At the present time but one more hoop and some minor parts of the breech mechanism have been completed, but they are all under way and it is not probable that any serious delay will occur in their delivery. A complete description of these forgings and the qualities required is reserved till the completion of the work.

Very respectfully, your obedient servant,

SIDNEY E. STUART,
Lieutenant, Ordnance Department, U. S. Army.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

APPENDIX 19.

FINAL CONSTRUCTION REPORT ON THE 12-INCH B. L. RIFLE—CAST-IRON WITH STEEL TUBE—FABRICATED BY THE SOUTH BOSTON IRON WORKS.

By Capt. D. A. LYLE, Ordnance Department, U. S. Army.

JANUARY, 1889.

REPORT.

This gun was contracted for September 24, 1883, and was finished December 15, 1888, thus requiring for its production five years, two months, and twenty-one days. It must not be understood that this period of time was necessary or actually employed upon the work of fabrication; it is merely the time the United States had to wait for the gun, from the date of their contract with the manufacturers.

PREVIOUS REPORTS.

The greater part of the construction work upon this gun has been given in previous reports. Four castings were made before the result was successful.

The details relating to the loss of the *first* and *second* castings will be found in my annual report for 1885, on pages 332 *et seq.*, Appendix 32, Report of Chief of Ordnance for the same year.

The details of the *third* casting are given on pages 310 *et seq.*, Appendix 22, Report of Chief of Ordnance for 1886.

The *fourth* and last casting was made April 5, 1886, and the data relating thereto are given on pages 314–322, Report of Chief of Ordnance for 1886.

Owing to inability to obtain suitable wire in time for wrapping the Whitworth steel tube, the Chief of Ordnance, on April 28, 1886, dispensed with the wire and decided to insert the plain steel tube. The construction and the dimensions of the tube were based upon this plan.

On page 353, Appendix 35, Report of Chief of Ordnance for 1887, will be found the detailed status of the work at that time. The fabrication had been suspended by the contractors, owing to the lapse of the appropriation, but it was resumed after the re-appropriation in April, 1888, of money to finish the gun, and was continued until its completion December 15, 1888.

DESCRIPTION.

The gun is of the general form of the Rodman model, and with exception of the steel tube bears a close resemblance to the 12-inch B. L. rifle cast-iron made under the same contract. The Whitworth steel tube is put in under a slight shrinkage (.002 inch) and has four radial securing pins through walls of gun, distributed near the front end, and four longitudinal securing pins—half in cast-iron and half in the steel—at the rear end. The breech bushing is screwed in after the insertion of the tube and is fixed in position by securing pins.

The breech mechanism is the French screw fermeture, and differs in no way from that of the 12-inch cast-iron B. L. rifle.

Principal dimensions.

Total length of gun—		
inches		360
feet		30
calibers		.30
Distance from breech to axis of trunnions	inches	119.5
muzzle to axis of trunnions	do	240.5
Total length of bore	do	342
rifled portion of bore	do	270.75
Length of first or forward slope	do	1.5
second slope	do	9.0
gas-check seat	do	3.0
breech recess	do	18.0
screw thread	do	16.0
Diameter, bore	do	12.0
shot chamber—rear end	do	12.2
powder chamber	do	13.5
steel breech bushing—over threads	do	24.0
at bottom of threads	do	23.2
Interior diameter screw box, bottom of threads	do	15.82
top of threads	do	15.02
Steel tube, total length	do	154.0
diameter	do	20.5
diameter tenon, front end	do	18.0
length of tenon	do	12.0
thickness of metal in walls of chamber	do	3.5
Exterior diameter, breech tenon	do	41.0
Maximum exterior, diameter of gun	do	56.0
Diameter at muzzle	do	24.0
Trunnions, diameter	do	15.0
length	do	7.0
diameter of rim bases	do	17.0
Distance between rim bases	do	55.1

Principal weights.

Total weight of gun	tons	54
Breech-block	pounds	970
Tray or console	do	187
Mushroom-head and spindle	do	194

Rifling (polygroove.)

Grooves, number of		60
width	inch	0.4483
depth	do	0.06
Lands, number of		60
width	inch	0.18
Rifling curve, semi-cubic parabola:		
Pitch, at origin		1 turn in 135 calibers.
at 34 inches from muzzle		1 turn in 40 calibers.
from 34 inches to muzzle, uniform		1 turn in 40 calibers.

MARKS.

The face of the muzzle is marked with the following characters placed in a circle concentric with the bore, viz: "12″—Tubed—S. B. I. W.—1888.—54 Tons.—D. A. L."

INTUBATION.

The seat in the casing for the tube was bored before the finish-turning of the tube. A cast-iron template was then made and carefully fitted to the bore to get the distance between the shoulders, etc. This template was calibered and the contacts of the shoulders tested with red lead. The tube was then made to correspond with the template, except that it had a prescribed diameter of 0.002 inch greater than the bore, to give a slight shrinkage.

The contract prescribed that the gun should be placed vertically in a pit, and heated for the insertion of the tube. The contractors proposed to heat the gun with the axis horizontal and to insert the tube in that position to save expense of handling gun. The Department would not authorize any change in the specifications, and the inspector informed the company that he could not authorize any change and registered his protest in writing against that method of insertion. The company proceeded with the horizontal insertion upon their own responsibility.

The gun was placed over the longitudinal bed-pit or foundation from which the new United States lathe had been removed, and rested upon two bearings, one at the breech and the other about 10 feet from the muzzle. The tube was placed upon a cradle in line with the bore and fitted with water apparatus for interior circulation of water in the bore. A long iron rod was attached to the front end of the tube and extended through a hole bored through the square left on the muzzle end of the casting in the prolongation of the axis of the bore. A rope and tackle were attached to this and anchored at the other end to a timber of the building. The object of the rod and tackle was to guide and drag forward the tube into the bore until it brought up against the shoulder at the front end. A second rope and tackle were similarly attached to the rear end and designed to withdraw the tube in case of its "sticking" before reaching its proper position.

FIRST ATTEMPT AT INSERTION OF TUBE.

When everything was ready the fires were lighted under the gun on the evening of June 25, 1888. The fuel used was charcoal and pine slabs. The fire extended from the trunnions to within a foot of the breech. The flames and heat were confined by a sheet or boiler-iron casing open at both ends, which covered in the gun from the breech to some distance beyond the trunnions.

A guage 0.025 inch larger than the bore was employed to test the expansion of the bore.

The fires were kept up all night of June 25, and the gun turned at intervals of one hour to get it heated uniformly.

Insertion.—June 26, 1888.
9 a. m. . Fire allowed to burn down.
10 a. m. : Guage went in freely.
11.10 to 10.15 a. m. : Tried to insert tube. Got it within a few inches of shoulders when the anchor at the forward end gave way; tried to withdraw tube by means of rear tackle; failed.
10.35 a. m. : Fitted new anchor in front and applied hydraulic jack in rear.

10.40 a. m.: Water hot to the hand.
11 a. m.: Steam arising from water.
11.10 a. m.: Fired up with pine slabs in front of trunnions; axis of trunnions horizontal.
3 p. m.: Jack at rear pushed in tube $\frac{1}{16}$ inch.
4.20 p. m.: Gun revolved; pushed in tube $\frac{1}{4}$ inch (?).
4.25 p. m.: Water connection ruptured; water got in screw-box.
4.35 p. m.: Tube went forward by jumps; supposed to go in $\frac{1}{4}$ inch. No accurate measurements could be taken. The tube was supposed to be up to the shoulder, but pressure kept up.
4.40 p. m.: Hydrant test, 69°; exit water, 119°; steam issuing from holes at muzzle. Fire allowed to die out.
June 27, 1888, a. m.: Tube had withdrawn incooling. Joint apparently open about $\frac{5}{16}$ inch, as felt by flat spring hook inserted in hole at muzzle.

SECOND ATTEMPT.

Monday, July 9, 1888.—Eight set-screws used to press in tube. These screws were engaged in the rear end of casting. All were set up tightly at starting. Fuel: pine slabs, charcoal, and coke.

12.00 m.: Fire lighted; trunnions horizontal.
1.00 p. m.: Tube extended somewhat.
1.30 p. m.: Rotated gun.
1.40 p. m.: Rotated gun one-half revolution.
1.45 p. m.: Set up all screws and urged fire near front end of tube.
2.20 p. m.: Began to rotate back 180°.
2.35 p. m.: Rotated 180°; water in tube warm.
2.50 p. m.: Joint apparently open one-fourth inch +; approximate.
3.00 p. m.: Screws all set up.
3.10 p. m.: Water quite hot; flow increased until cool, and then turned gun
3.12 p. m.: Started to turn gun with crane.
3.45 p. m.: All the screws set up again.
4.25 p. m.: One bolt broke in screwing up.
4.30 p. m.: Rotated gun 180°.
4.45 p. m.: One side of joint apparently closed and the other apparently open.
5.05 p. m.: Tightened up screws and increased fire.
5.45 p. m.: Turned gun 180°.
6.00 p. m.: Screwed up again; water in bore cool.
6.30 p. m.: Diminished water until it came out hot, and then turned on full head to cool suddenly.
7.00 p. m.: Rotated gun 180°.
7.15 p. m.: Broke second screw off; set up remainder.
7.20 p. m.: Broke third screw.
7.25 p. m.: Choked water supply
7.35 p. m.: Fire pushed forward from breech to cut off heat there.
7.40 p. m.: Rotated gun 180°.
8.00 p. m.: Water nearly off to get gun-tube hot; fired up under front end of tube; could hold hand in water, however.
8.22 p. m.: Water on again.
8.25 p. m.: Rotated gun 180°.
8.30 p. m.: Set up all screws.
8.45 p. m.: Rotated 180°.
8.50 p. m.: Set up all screws.
9.00 p. m.: Set up all screws; fire in front of trunnions only.
9.39 p. m.: Ceased work; left men to keep up fire in front of trunnions; cooling breech. Fire was kept up through night. All the screw-bolts broke as the contraction took place.

July 10, 1888, a. m. Tube apparently in same position as before.

THIRD ATTEMPT.

The third and last trial was made July 19, 1888. Below is given the detailed account of the operations.

July 19, 1888:
7.30 a. m.: Fire lighted under gun; fuel: sawdust, pine slabs, charcoal and coke; gun rotated once before 9.30 a. m.; water in tube cold. Fire extended from 1 foot in front of face of breech to 6 feet in front of trunnions.
10.15 a. m.: gun rotated 180°; chill off the water.

10.20 a. m.: Used hydraulic jack to press in tube.

10.50 a. m.: Gun rotated 180°; fire extended farther along gun and more intense than on either of the previous occasions.

10.55 a. m.: Pumped on jack.

11.25 a. m.: Set up all 8 screws in breech.

11.35 a. m.: Screws all tight; no movement of tube observed.

11.45 to 11.50: Rotated 180°; water cool; over 40 gallons per minute going through bore of tube.

11.55 a. m. to 12.05 p. m.: Pump and screws worked.

12.10 p. m.: Hydraulic jack leaking; out of order.

12.20 p. m.: Hydraulic jack repaired; all right.

12.30 to 12.40 p. m.: Hydraulic jack worked and fired up in front of trunnions.

12.45 p. m.: Fired up with coke whole length of tube; pump-valve of jack does not work.

1 to 1.05 p. m.: Rotated 180°; hot fire; water cool.

1.20 p. m.: Rotated 180°; water cool, but 2° warmer than last observation.

1.40 p. m.: Rotated 180°; pump-valve does not work; relying on screws to set up tube.

2 p. m.: Tightened screws; jack does not work.

2.10 p. m.: Rotated 180°; set up screws.

2.45 p. m.: Rotated 180°; set up screws while turning gun.

3.15 p. m.: Rotated 180°; set up screws.

4 p. m.: Rotated 180°; set up screws.

4.13 p. m.: Set up screws.

4.40 p. m.: Rotated 180°; set up screws.

4.50 p. m.: Fire lowered in rear of trunnions and sheet-iron casing removed at breech to let it cool and grip tube, so as to draw front end up to shoulder; fire kept up in front of trunnions; water cool; chill off.

5 p. m.: Rotated 180°; set up screws.

5.20 p. m.: Set up screws.

5.30 p. m.: Rotated 180°.

5,50 p. m.: Changed three long screw-bolts for short ones.

6. p. m.: Rotated 180°; fired up in front of trunnions. William P. Hunt, jr., stated that he would keep fire up in front of trunnions all night, and hoped to get tube up to shoulders by cooling rear end of gun.

6.45 p. m.: Hydraulic jack useless; removed; relying on screws.

6.55 p. m.: Set up all screws to their full length of thread; can not turn more.

7.55 p. m.: Removed casing as far as trunnions to cool breech; fired up in front of trunnions; tube apparently withdrawn a little.

8.10 to 8.15 p. m.: Rotated gun, 180°.

8.25 p. m.: Fired up in front of trunnions; tube apparently withdrawn a little, probably due to contraction of casing.

9.00 p. m.: Fired up in front of trunnions; tube projecting at rear a little more; contraction of casing.

9.20 p. m.: Rotated gun 90°; one long bolt broke, leaving seven.

9.45 p. m.: Bolt replaced; eight now.

9.50 p. m.: Rotated gun 90°.

10.30 p. m.: Bolt broke and was removed.

10.40 p. m.: Replaced bolt and nut. The foreman, Signor Ambrosi, decided not to rotate gun again for fear of breaking bolts; slabs put on top of gun to keep up the heat there; apparently no change in tube.

11.25 p. m.: Crackling sound heard.

11.30 p. m.: Bolt broke from strain due to cooling of gun.

11.35 p. m.: Bolt replaced; eight again.

11.55 p. m.: Bolt broke off.

July 20, 1888, 12.05 a. m.: Bolt broke off.

12.10 a. m.: Both bolts replaced; eight again.

12.35 a. m.: Bolt broke off.

12.45 a. m.: Bolt replaced; eight on.

3.20 a. m.: Bolt broke off; seven now.

3.25 a. m.: Bolt replaced; eight again.

5.25 a. m.: Bolt broken.

5.30 a. m.: Work ceased; gun left to cool; no fire.

July 23, 1888.—Water apparatus removed and two preliminary impressions taken of joint of tube in bore 180° apart. No. 1, no sign of joint. No. 2 showed slight joint, probably due to the bevel removed from edge of bore.

July 24, 1888.—Six gutta-percha impressions taken around joint; slight traces of joint, but may be filled with rust, as the tube cup leaked a little.

July 27, 1888.—Sulphur impressions taken, 180° apart; joint apparently good. It was decided that the tube was up to its seat.

July 28, 1888.—Began moving gun to lathe.

By August 1, 1888, the gun was in the lathe and work resumed and continued until the gun was finished, December 15, 1888. Gutta-percha impressions taken of the finished boring and again after rifling showed no sign of opening at joint.

After final star-gauging of bore a cylinder gauge, 48 inches long and 11.996 inches in diameter, was passed into the bore from each end and stopped at the junction of the steel tube with the cast-iron casing. This was probably due to the bar thrown up by the rifling tool in passing from one metal to the other. The spot was lapped out, when the gauge passed through the bore each way without difficulty.

The ordinates of the former for the rifling curve were carefully measured and verified. The greatest variation did not exceed a few hundredths of an inch.

With the completion of this gun close all contracts between the Ordnance Department and the South Boston Iron Works.

Appended to this report will be found six tables, giving additional data relating to the 12-inch cast-iron B. L. rifles with steel tubes.

TABLE I.—*Showing the exterior diameters of the 12-inch B. L. rifle, steel tubed.*

Distance in inches from muzzle.	Exterior diameter.		
	Prescribed.	Actual.	Variation.
	Inches.	*Inches.*	*Inch.*
At muzzle	24	24	0.0
5	24	24	.0
15	24.875	24.875	.0
25	24.7125	24.75	+ .0375
35	25.05	25.05	.0
45	25.40	*25.40	.0
55	25.75	25.75	.0
65	26.1	26.1+	.0
75	26.5	26.55	+ .05
85	27.1	27.1	.0
95	27.8	27.78	— .02
105	28.7	28.65+	— .05
115	29.7	29.7	.0
125	30.8	30.85	+ .05
135	33.1	32.15	+ .05
145	33.45	33.52	+ .07
155	34.95	35.0+	+ .05
165	36.66	36.7+	+ .04
175	38.46	38.5	+ .04
185	40.75	40.85 (?)	+ .10
195	43.25	43.3	+ .05
205	45.45	45.5	+ .05
215	47.75	*47.5	— .25
225	49.7	*49.5	— .02
235	51.3	51.4	+ .10
245	52.55	52.6	+ .05
255	53.6	53.65	+ .05
265	54.5	54.55	+ .05
275	55.3	55.35	+ .05
285	55.6	55.61	+ .01
295	55.94	54.90	— .04
305	56.00	55.9+	— .10
315	55.94	55.9	— .04
325	55.75	55.75	.0
334	55.56	55.55	— .01
343	55.00	55.0	.0
350.125	53.02	53.05	+ .03
357.25	41.0	40.95	— .05
360.00 breech	41.0	40.95	— .05

* Casting too scant to give full size.

TABLE II.—*Star gauging and interior calipering of seat for tube in 12-inch cast-iron rifle, tubed with steel.*

Distance from front shoulder.	Interior calipers.		Star gauging.	
	Horizontal.	Vertical.	Horizontal.	Vertical.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
4	18.005	18.005	18.006	18.006
5	18.004	18.006	18.005	18.006
6	18.004	18.004	18.006	18.005
7	18.004	18.004	18.005	18.006
8	18.004	18.005	18.004	....
9	18.004	18.005	....	18.003
10	18.004	18.005	18.005	18.006
11	18.004	18.005	18.006	18.006
Mean	18.004125	18.004875	18.006	....
Grand mean	18.00452+		18.0055	
14	20.496	20.498	....	....
15	20.502	20.501	20.501	20.502
16	20.502	20.501	20.501	20.561
17	20.502	20.500	20.501	20.501
18	20.502	20.500	20.501	20.501
19	20.502	20.500	20.501	20.501
20	20.502	20.500	20.500	20.501
21	20.502	20.501	20.501	20.502
22	20.502	20.501	20.501	20.501
23	20.502	20.501	20.501	20.501
24	20.502	20.501	20.501	20.501
25	20.501	20.501	20.501	20.502
26	20.501	20.501	20.501	20.501
27	20.501	20.501	20.501	20.501
28	20.501	20.502	20.501	20.501
29	20.501	20.502	20.501	20.501
30	20.501	20.502	20.502	20.501
31	20.501	20.502	20.502	20.502
32	20.501	20.502	20.502	20.501
33	20.503	20.503	20.501	20.501
34	20.503	20.503	20.501	20.501
35	20.503	20.503	20.501	20.502
36	20.503	20.503	20.501	20.502
37	20.503	20.503	20.501	20.502
38	20.503	20.503	20.501	20.502
39	20.503	20.503	20.502	20.502
40	20.503	20.503	20.502	20.502
41	20.503	20.502	20.502	20.502
42	20.503	20.502	20.502	20.501
43	20.503	20.502	20.502	20.502
44	20.503	20.502	20.501	20.502
45	20.502	20.502	20.501	20.501
46	20.502	20.502	20.501	20.502
47	20.502	20.502	20.502	20.502
48	20.502	20.502	20.502	20.501
49	20.502	20.502	20.502	10.501
50	20.502	20.502	20.501	20.501
51	20.503	20.503	20.501	20.501
52	20.502	20.503	20.502	20.502
53	....	....	....	....
54	20.502	20.503	20.502	20.502
55	20.502	20.503	20.502	20.502
56	20.502	20.501	20.501	20.501
57	20.502	20.501	20.502	20.501
58	20.503	20.501	20.502	20.502
59	20.503	20.501	20.502	20.502
60	20.503	20.501	20.502	20.502
61	20.503	20.501	20.502	20.501
62	20.503	20.501	29.502	20.502
63	20.503	20.501	20.502	20.503
64	20.503	20.501	20.502	20.502
65	20.503	20.501	20.502	20.502
66	20.503	20.501	20.502	20.501
67	20.503	20.501	20.502	20.502
68	20.503	20.501	20.503	20.501
69	20.502	20.501	20.503	20.502
70	20.502	20.501	20.502	20.502
71	20.502	20.501	20.502	20.502
72	20.502	20.501	20.502	20.502
73	20.502	20.501	20.502	20.503
74	20.503	20.502	20.502	20.502
75	20.503	20.502	20.502	20.502
76	20.503	20.502	20.502	20.502
77	20.503	20.502	20.502	20.503
78	20.503	20.502	20.502	20.502
79	20.503	20.502	20.502	20.502
80	20.502	20.502	20.502	20.502

TABLE II.—*Star gauging and interior calipering of seat for tube in 12-inch cast-iron rifle, tubed with steel*—Continued.

Distance from front shoulder.	Interior calipers.		Star gauging.	
	Horizontal.	Vertical.	Horizontal.	Vertical.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
81	20.502	20.502	20.502	20.503
82	20.502	20.502	20.502	20.502
83	20.502	20.501	20.502	20.502
84	20.502	20.501	20.502	20.502
85	20.503	20.501	20.501	20.501
86	20.503	20.501	20.502	20.502
87	20.503	20.501	20.502	20.502
88	20.502	20.501	20.502	20.501
89	20.502	20.501	20.502	20.502
90	20.502	20.501	20.502	20.501
91	20.502	20.501	20.502	20.502
92	20.502	20.501	20.502	20.501
93	20.502	20.501	20.502	20.501
94	20.503	20.501	20.501	20.501
95	20.502	20.501	20.502	20.502
96	20.502	20.501	20.503	20.502
97	20.502	20.501	20.503	20.503
98	20.502	20.501	20.502	20.503
99	20.502	20.501	20.503	20.502
100	20.502	20.501	20.502	20.503
101	20.502	20.502	20.502	20.503
102	20.502	20.502	20.502	20.503
103	20.502	20.502	20.502	20.502
104	20.502	20.502	20.502	20.502
105	20.501	20.502	20.502	20.502
106	20.501	20.502	20.502	20.502
107	20.501	20.501	20.502	20.502
108	20.501	20.501	20.501	20.502
109	20.501	20.501	20.502	20.502
110	20.501	20.501	20.501	20.501
111	20.502	20.502	20.501	20.501
112	20.502	20.502	20.501	20.501
113	20.502	20.502	20.501	20.502
114	20.502	20.502	20.501	20.502
115	20.502	20.502	20.501	20.502
116	20.501	20.501	20.501	20.502
117	20.501	20.501	20.501	20.502
118	20.501	20.501	20.500	20.502
119	20.501	20.501	20.501	20.502
120	20.501	20.501	20.501	20.502
121	20.501	20.501	20.501	20.502
122	20.501	20.501	20.500	20.502
123	20.501	20.501	20.500	20.502
124	20.501	20.501	20.501	20.502
125	20.501	20.501	20.501	20.502
126	20.501	20.501	20.501	20.501
127	20.501	20.501	20.500	20.502
128	20.501	20.501	20.500	20.501
129	20.501	20.501	20.500	20.501
130	20.501	20.501	20.500	20.501
131	20.501	20.502	20.501	20.501
132	20.501	20.502	20.501	20.502
133	20.501	20.502	20.500	20.502
134	20.501	20.502	20.501	20.501
135	20.501	20.501	20.500	20.501
136	20.501	20.501	20.501	20.501
137	20.502	20.501	20.500	20.501
138	20.502	20.501	20.500	20.500
139	20.502	20.501	20.501	20.501
140	20.502	20.501	20.501	20.500
141	20.502	20.500	20.501	20.501
142	20.502	20.500	20.498	20.500
143	20.502	20.500	20.500	20.501
144	20.502	20.500	20.500	20.501
145	20.501	20.500	20.500	20.501
146	20.501	20.501	20.500	20.501
147	20.501	20.501	20.500	20.501
148	20.501	20.501	20.500	20.501
149	20.501	20.501	20.500	20.500
150	20.501	20.501	20.499	20.501
151	20.500	20.500	20.501	20.500
152	20.500	20.500	20.500	20.500
153	20.500	20.500	20.500	20.500
154	20.500	20.500	20.500	20.500
Mean	20.5018	20.5013	20.5014	20.5014
Grand mean	20.5014+			

TABLE III.—*Exterior calipering of steel tube for 12-inch B. L. cast-iron rifle, tubed with steel.*

Distance from breech of tube.	Horizontal.	Vertical.	Distance from breech of tube.	Horizontal.	Vertical.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1			82	20.499+	20.500
2			83	20.499+	*20.500
3	20.499+	20.501	84	20.499+	20.500
4	20.499+	20.501	85	20.499+	20.500
5	20.499+	20.501	86	20.499+	20.500
6	20.499+	20.501	87	20.499+	20.500
7	20.499+	20.501	88	20.499+	20.500
8	20.499+	20.501	89	20.499+	20.500
9	20.499+	20.501	90	20.499+	20.500
10	20.499+	20.501	91	20.499+	20.500
11	20.499+	20.501	92	20.499+	20.500
12	*20.499	20.501	93	20.499+	20.500
13	20.499+	20.501	94	20.499+	20.500
14	20.499+	20.501	95	20.499+	20.500
15	20.499+	20.5005	96	20.499+	20.500
16	*20.499	20.5005	97	20.499+	20.500
17	20.499+	20.5005	98	20.499+	20.500
18	20.499+	20.5005	99	20.499+	20.500
19	20.499+	20.5005	100	20.499+	20.499+
20	20.499+	20.5005	101	20.499	20.499+
21	20.499+	20.5005	102	20.499	20.499+
22	20.499+	20.5005	103	20.499	20.499+
23	20.499+	20.5005	104	20.499	*20.500
24	20.499+	20.5005	105	20.499	*20.500
25	20.499+	20.5005	106	20.499	20.500
26	20.499+	20.5005	107	20.499	20.500
27	20.499+	20.5005	108	20.499	20.500
28	20.499+	20.5005	109	20.499	20.500
29	20.499+	20.5005	110	20.499	20.500
30	20.499+	20.5005	111	20.499	20.500
31	20.499+	20.5005	112	20.499	20.500
32	20.499+	20.5005	113	20.499	20.500
33	20.499+	20.5005	114	20.499	20.550
34	20.499+	20.501	115	20.499	20.000
35	20.499+	20.501	116	20.499	20.499+
36	20.499+	20.501	117	20.499	20.499+
37	20.499+		118	20.499	20.499+
38	20.499+	20.5005	119	20.499	20.499+
39	20.499+	20.5005	120	20.499	20.499+
40	20.499+	20.5005	121	20.499	20.499+
41	20.499+	20.501	122	20.499	20.499+
42	20.499+	20.501	123	20.499	20.499+
43	20.499+	20.501	124	20.499	20.499+
44	20.499+	20.501	125	20.499	20.499+
45	20.499+	20.501	126	20.499	20.499+
46	20.499+	‡20.500	127	20.499	20.499+
47	20.499+	20.500	128	20.499	*20.500
48	20.499+	20.500	129	20,499	20.500
49	20.499+	20.500	130	20.499	20.500
50	†20.490	20.500	131	20.499	20.500
51	20.499	20.500	132	20.499	20.500
52	20.499	20.500	133	20.499	20.500
53	‡20.499	‡20.500	134	20.499	20.500
54	20.499	20.500	135	20.499	20.500
55	20.499	20.500	136	20.499	20.500
56	20.499	20.500	137	20.499	20.500
57	20.499	20.500	138	20.499	20.500
58	20.499	20.500	139	20.499	20,500
59	20.499	20.500	140	20.499	20.500
60	*20.499	20.500	141	20.499	*20.500
61	20.499	20.500	142	Curve shoulder.	
62	20.499	20.500	143		
63	20.499	20.500	144	*18.005	18.005+
64	20.499	20.500	145	18.005	18.005+
65	20.499	20.500	146	18.005	18.005+
66	20.499+	20.500	147	§18.005	18.005+
67	20.499+	20.500	148	*18.005	18.005+
68	20.499+	20.500	149	18.005+	18.005+
69	20.499+	20.500	150	18.005+	18.005+
70	20.499+	20.500	151	18.005+	18.005+
71	20.499+	20.500	152	18.005+	18.005+
72	20.499+	20.500	153	Curve shoulder.	
73	20.499+	20.500	154		
74	20.499+	*20.500		Horizontal.	Vertical.
75	20.499+	20.500			
76	20.499+	20.500	Means	20.499	20.50024+
77	20.499+	20.500	Means	18.005	18.005
78	20.499+	20.500	Grand mean	20.49962	Tube.
79	20.499+	20.500	Grand mean	18.005	
80	20.499+	20.500	Size of casing same scale	20,497+	
81	20.499+	20.500			

* Scant. † Sharp. ‡ Tight. § Very scant.

TABLE IV.—*Star gauging of 12-inch B. L. cast-iron rifle, before rifling and after finish boring.*

Distance from muzzle.	Horizontal.	Vertical.	Distance from muzzle.	Horizontal.	Vertical.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
270	(1)	(2)	191	12.002	12.003
269	12.003	12.003	190	12.002	12.003
268	12.003	12.003	189	12.002	12.003
267	12.003	12.003	188	12.002	12.003
266	12.003	12.003	187	12.002	12.003
265	12.003	12.003	186	12.002	12.003
264	12.003	12.003	185	12.002	12.003
263	12.003	12.003	184	12.002	12.003
262	12.003	12.003	183	12.003	12.003
261	12.003	12.003	182	12.003	12.003
260	12.003	12.003	181	12.003	12.003
259	12.003	12.003	180	12.003	12.003
258	12.003	12.003	179	12.003	12.003
257	12.003	12.003	178	12.003	12.003
256	12.003	12.003	177	12.003	12.003
255	12.003	12.003	176	12.003	12.003
254	12.003	12.003	175	12.003	12.003
253	12.003	12.003	174	12.003	12.003
252	12.003	12.003	173	12.003	12.003+
251	12.003	12.003	172	12.003	12.003+
250	12.003	12.003	171	12.003	12.003+
249	12.003	12.003	170	12.003	12.003+
248	12.003	12.003	169	12.003	12.003+
247	12.003	12.003	168	12.003	12.003+
246	12.003	12.003	167	12.003	12.003+
245	12.003	12.003	166	12.003	12.003+
244	12.003	12.003	165	12.003	12.003+
243	12.003	12.003	164	12.003	12.003+
242	12.003	12.003	163	12.003	12.003+
241	12.003	12.003	162	12.003	12.003+
240	12.003	12.003	161	12.003	12.003+
239	12.003	12.003	160	12.003	12.003+
238	12.003	12.003	159	12.003	12.003+
237	12.003	12.003	158	12.003	12.003+
236	12.003	12.003	157	12.003	12.003+
235	12.003	12.003	156	12.003	12.003+
234	12.003	12.003	155	12.003	12.003+
233	12.003	12.003	154	12.003	12.003+
232	12.003	12.003	153	12.003	12.003+
231	12.003	12.003	152	12.003	12.003+
230	12.003	12.003	151	12.003	12.003+
229	12.003	12.003	150	12.003	12.003+
228	12.003	12.003	149	12.003	12.003+
227	12.003	12.003	148	12.003	12.003+
226	12.003	12.003	147	12.003	12.003+
225	12.003	12.003	146	12.003	12.003+
224	12.003	12.003	145	12.003	12.003+
223	12.003	12.003	144	12.003	12.003+
222	12.003	12.003	143	12.003	12.003+
221	12.003	12.003	142	12.003	12.003+
220	12.003	12.003	141	12.003	12.003+
219	12.003	12.003	140	12.003	12.003+
218	12.003	12.003	139	12.003	12.003+
217	12.003	12.003	138	12.003	12.003+
216	12.003	12.003	137	12.003	12.003+
215	12.003	12.003	136	12.003	12.003+
214	12.003	12.003	135	12.003	12.003+
213	12.003	12.003	134	12.003	12.003+
212	12.003	12.003	133	12.003	12.003+
211	12.003	12.003	132	12.003	12.003+
210	12.003	12.003	131	12.003	12.003+
209	12.003	12.003	130	12.003	12.003+
208	12.003	12.003	129	12.003	12.003+
207	12.003	12.003	128	12.003	12.003+
206	12.003	12.003	127	12.003	12.003+
205	12.001	12.003	126	12.003	12.003+
204	12.003	12.003	125	12.003	12.003+
203	12.002	12.003	124	12.003	12.003+
202	12.002	12.003	123	12.003	12.003+
201	12.002	12.003	122	12.003	12.003+
200	12.002	12.003	121	12.003	12.003+
199	12.002	12.003	120	12.003	12.003+
198	12.002	12.003	119	12.003	12.003+
197	12.002	12.003	118	12.003	12.003+
196	12.002	12.003	117	12.003	12.003+
195	12.002	12.003	116	12.003	12.003+
194	12.002	12.003	115	12.003	12.003+
193	12.002	12.003	114	12.003	12.003+
192	12.002	12.003	113	12.003	12.003+

TABLE IV.—*Star gauging of 12-inch B. L. cast-iron rifle before rifling and after finish boring.*

Distance from muzzle.	Horizontal.	Vertical.	Distance from muzzle.	Horizontal.	Vertical.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
112	12.003	12.003+	56	12.003	12.003+
111	12.003	12.003+	55	12.003	12.003+
110	12.003	12.003+	54	12.003	12.003+
109	12.003	12.003+	53	12.003	12.003+
108	12.003	12.003+	52	12.003	12.003+
107	12.003	12.003+	51	12.003	12.003+
106	12.003	12.003+	50	12.003	12.003+
105	12.003	12.003+	49	12.003	12.003+
104	12.003	12.003+	48	12.003	12.003+
103	12.003	12.003+	47	12.003	12.003+
102	12.003	12.003+	46	12.003	12.003+
101	12.003	12.003+	45	12.003	12.003+
100	12.003	12.003+	44	12.003	12.003+
99	12.003	12.003+	43	12.003	12.003+
98	12.003	12.003+	42	12.003	12.003+
97	12.003	12.003+	41	12.003	12.003+
96	12.003	12.003+	40	12.003	12.003+
95	12.003	12.003+	39	12.003	12.003+
94	12.003	12.003+	38	12.003	12.003+
93	12.003	12.003+	37	12.003	12.003+
92	12.003	12.003+	36	12.003	12.003+
91	12.003	12.003+	35	12.003	12.003+
90	12.003	12.003+	34	12.003	12.003+
89	12.003	12.003+	33	12.003	12.003+
88	12.003	12.003+	32	12.003	12.003+
87	12.003	12.003+	31	12.003	12.003+
86	12.003	12.003+	30	12.003	12.003+
85	12.003	12.003+	29	12.003	12.003+
84	12.003	12.003+	28	12.003	12.003+
83	12.003	12.003+	27	12.003	12.003+
82	12.003	12.003+	26	12.003	12.003+
81	12.003	12.003+	25	12.003	12.003+
80	12.003	12.003+	24	12.003	12.003+
79	12.003	12.003+	23	12.003	12.003+
78	12.003	12.003+	22	12.003	12.003+
77	12.003	12.003+	21	12.003	12.003+
76	12.003	12.003+	20	12.003	12.003+
75	12.003	12.003+	19	12.003	12.003+
74	12.003	12.003+	18	12.003	12.003+
73	12.003	12.003+	17	12.003	12.003+
72	12.003	12.003+	16	12.003	12.003+
71	12.003	12.003+	15	12.003	12.003+
70	12.003	12.003+	14	12.003	12.003+
69	12.003	12.003+	13	12.003	12.003+
68	12.003	12.003+	12	12.003	12.003+
67	12.003	12.003+	11	12.003	12.003+
66	12.003	12.003+	10	12.003	12.003+
65	12.003	12.003+	9	12.003	12.003+
64	12.003	12.003+	8	12.003	12.003+
63	12.003	12.003+	7	12.003	12.003+
62	12.003	12.003+	6	12.003	12.003+
61	12.003	12.003+	5	12.003	12.003+
60	12.003	13.003+	4	12.003	12.003+
59	12.003	12.003+	3	12.003	12.003+
58	12.003	12.003+	2	12.003	12.003+
57	12.003	12.003+	1	12.003	12.003+

NOTE.—For chamber, see next table.

TABLE V.—*Star gauging of chamber, etc., of 12-inch B. L. Rifle—cast-iron, with steel tube.*

Distance from breech.	Distance from muzzle.	Horizontal.	Vertical.	Remarks.
Inches.	*Inches.*	*Inches.*	*Inches.*	
90......	270	....	....	....
....	270.75	....	....	
89......	271	12.205	12.[illegible]06	Shot chamber =3.25″.
88......	272	12.205	12.206	
87......	273	12.205	12.206	
86......	274	....	....	Slope = 9″.
85......	275	....	....	
84......	276	....	....	
83......	277	....	....	
82......	278	....	....	
81......	279	....	....	
80......	280	....	....	
79......	281	....	....	
78......	282	....	....	
77......	283	....	....	
76......	284	13,492	13,493	Chamber cylin. part = 56″.
75......	285	13,492	13,490	
74......	286	13,494	13,492	
73......	287	13,494	13,492	
72......	288	13,494	13,494	
71......	289	13,494	13,494	
70......	290	13,494	13,494	
69......	291	13,494	13,494	
68......	292	13,494	13,495	
67......	293	13,494	13,495	
66......	294	13,495	13,494	
65......	295	13,495	13,494	
64......	296	13,495	13,494	
63......	297	13,495	13,494	
62......	298	13,495	13,495	
61......	299	13,495	13,495	
60......	300	13,495	13,495	
59......	301	13,495	13,495	
58......	302	13,495	13,495	
57......	303	13,495	13,495	
56......	304	13,495	13,495	
55......	305	13,495	13,495	
54......	306	13,495	13,495	
53......	307	13,495	13,495	
52......	308	13,496	13,495	
51......	309	13,496	13,495	
50......	310	13,496	13,495	
49......	311	13,496	13,495	
48......	312	13,496	13,495	
47......	313	13,496	13,495	
46......	314	13,496	13,495	
45......	315	13,496	13,495	Chamber cylin. part = 56″.
44......	316	13,496	13,495	
43......	317	13,496	13,495	
42......	318	13,496	13,495	
41......	319	13,496	13,495	
40......	320	13,496	13,496	
39......	321	13,496	13,496	
38......	322	13,496	13,496	
37......	323	13,496	13,496	
36......	324	13,496	13,496	
35......	325	13,496	13,496	
34......	326	13,496	13,496	
33......	327	13,496	13,497	
32......	328	13,504	13,500	
31......	329	13,504	13,503	
30......	330	13,504	13,504	
29......	331	13,504	13,503	
28......	332	13,504	13,503	
27......	333	13,504	13,503	
26......	334	13,504	13,504	
25......	335	13,505	13,504	
24......	336	13,505	13,504	
23......	337	13,505	13,504	
22......	338	13,505	13,504	
21......	339	13,505	13,504	
20......	340			Gas-check seat = 3″.
19......	341			
18......	342			
17......	343			Screw box = 18″.
16......	344			
15......	345			
14......	346			
13......	347			
12......	348			
11......	349			
10......	350			
9......	351			
8......	352			
7......	353			
6......	354			
5......	355			
4......	356			
3......	357			
2......	358			
1......	359			
0......	360			

TABLE VI.—*Star-gauging of rifling of 12-inch cast-iron B. L. rifle, steel-tubed.*

[60 grooves; 60 lands. Diameters measured across grooves.]

Distance from muzzle.	Diameter.	Distance from muzzle.	Diameter.	Distance from muzzle.	Diameter.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
270......	....	179......	12.126	89......	12.124
269......	....	178......	12.126	88......	12.124
268......	12.12	177......	12.126	87......	12.124
267......	12.12	176......	12.126	86......	12.124
266......	12.12	175......	12.125	85......	12.124
265......	12.12	174......	12.125	84......	12.124
264......	12.12	173......	12.125	83......	12.124
263......	12.12	172......	12.125	82......	12.124
262......	12.12	171......	12.125	81......	12.124
261......	12.12	170......	12.125	80......	12.124
260......	12.12	169......	12.125	79......	12.124
259......	12.12	168......	12.125	78......	12.124
258......	12.12	167......	12.125	77......	12.124
257......	12.12	166......	12.126	76......	12.124
256......	12.12	165......	12.125	75......	12.124
255......	12.12	164......	12.125	74......	12.124

TABLE VI.—*Star-gauging of rifling of 12 inch cast-iron B. L. rifle, steel-tubed*—Cont'd.

Distance from muzzle.	Diameter.	Distance from muzzle.	Diameter.	Distance from muzzle.	Diameter.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
254	12.12	163	12.125	73	12.124
253	12.12	162	12.125	72	12.124
252	12.12	161	12.125	71	12.124
251	12.12	160	12.125	70	12.124
250	12.12	159	12.125	69	12.124
249	12.12	158	12.126	68	12.124
248	12.12	157	12.126	67	12.124
247	12.12	156	12.127	66	12.124
246	12.12	155	12.126	65	12.124
245	12.12	154	12.126	64	12.124
244	12.12	153	12.126	63	12.124
243	12.12	152	12.126	62	12.124
242	12.12	151	12.126	61	12.124
241	12.12	150	12.126	60	12.124
240	12.12	149	12.126	59	12.124
239	12.12	148	12.126	58	12.124
238	12.12	147	12.126	57	12.124
237	12.12	146	12.126	56	12.124
236	12.12	145	12.125	55	12.124
235	12.12	144	12.125	54	12.124
234	12.12	143	12.125	53	12.124
233	12.12	142	12.125	52	12.124
232	12.12	141	12.125	51	12.124
231	12.12	140	12.125	50	12.124
230	12.12	139	12.125	49	12.124
229	12.12	138	12.125	48	12.124
228	12.12	137	12.125	47	12.124
227	12.12	136	12.125	46	12.124
226	12.12	135	12.125	45	12.124
225	12.12	134	12.125	44	12.124
224	12.12	133	12.125	43	12.124
223	12.121	132	12.125	42	12.124
222	12.121	131	12.125	41	12.124
221	12.121	130	12.124	40	12.124
220	12.111	129	12.124	39	12.124
219	12.121	128	12.124	38	12.124
218	12.121	127	12.124	37	12.124
217	12.121	126	12.124	36	12.124
216	12.121	125	12.124	35	12.124
215	12.121	124	12.124	34	12.124
214	12.121	123	12.124	33	12.124
213	12.121	122	12.124	32	12.124
212	12.121	121	12.124	31	12.124
211	12.121	120	12.124	30	12.124
210	12.121	119	12.124	29	12.124
209	12.121	118	12.124	28	12.124
208	12.121	117	12.124	27	12.124
207	12.121	116	12.124	26	12.124
206	12.121	115	12.124	25	12.124
205	12.121	114	12.124	24	12.124
204	12.121	113	12.124	23	12 124
203	12.121	112	12.124	22	12.124
202	12.121	111	12.124	21	12.124
201	12.121	110	12.124	20	12.124
200	12.121	109	12.124	19	12.124
199	12.121	108	12.124	18	12,124
198	12.121	107	12.124	17	12.124
197	12.121	106	12.124	16	12.124
196	12.121	105	12.124	15	12.123
195	12.121	104	12.124	14	12.123
194	12.121	103	12.124	13	12.123
193	12.123	102	12.124	12	12.123
192	12.123	101	12.124	11	12.123
191	12.123	100	12.124	10	12.121
190	12.124	99	12.124	9	12.121
189	12.124	98	12.124	8	12.121
188	12.124	97	12.124	7	12.121
187	12.124	96	12.124	6	12.121
186	12.124	95	12.124	5	12.125
185	12.124	94	12.124	4	12.125
184	12.125	93	12.124	3	12.125
183	12.126	92	12.124	2	12.125
182	12.126	91	12.124	1	12.125
181	12.126	90	12.124	*0	12.125
180	12.126				

*Muzzle.

APPENDIX 20.

ADVERTISEMENT, SPECIFICATIONS, PROPOSALS, AND CONTRACT FOR STEEL FORGINGS FOR 8-INCH, 10-INCH, AND 12-INCH GUNS, TO BE PROCURED UNDER THE ACT OF SEPTEMBER 22, 1888.

(6 plates.)

[Advertisement.]

PROPOSALS FOR 8-INCH, 10-INCH, AND 12-INCH STEEL GUN FORGINGS.

ORDNANCE OFFICE,
WAR DEPARTMENT,
Washington, November 15, 1888.

Sealed proposals, in duplicate, will be received at this office from steel manufacturers, who are resident citizens of the United States, until 1 o'clock p. m., on Thursday, December 20, 1888, at which time they will be publicly opened, for supplying the Ordnance Department, U. S. Army, with complete sets of rough finished, oil-tempered, and annealed steel forgings, of American manufacture, for 8-inch, 10-inch, and 12-inch guns. Blank forms on which proposals must be made and all information required by bidders can be had upon application.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

INSTRUCTIONS TO BIDDERS FOR 8-INCH, 10-INCH, AND 12-INCH STEEL GUN FORGINGS.

ORDNANCE OFFICE,
WAR DEPARTMENT,
Washington, November 15, 1888.

The sets of forgings for 8-inch, 10-inch, and 12-inch steel guns, for which proposals are invited under newspaper advertisement of this date, must conform in quality and dimensions to the specifications and drawings to be had at this office.

Bidders will state the average price per pound for the forgings for each caliber, and the number of complete sets of forgings for each caliber which they will furnish.

The total price bid must be about $1,455,000.

Under the terms of the act of Congress approved September 22, 1888, under which proposals are invited, and the proportionate number of sets of forgings for each caliber required by the Department, the number of sets will not be less than 21 for guns of 8-inch caliber, 22 for guns of 10-inch caliber, and 14 for guns of 12-inch caliber. Any increase, proposed by bidders, in the number of sets of forgings to be furnished will be as evenly distributed as possible among the several calibers.

Bidders will also state the date when the deliveries of complete sets of forgings for each caliber will commence, the rate at which deliveries will be made after the first delivery, and when deliveries of complete sets of forgings for each caliber will be completed.

Bidders must have or agree, in case their proposal is accepted, to erect in the United States a suitable plant, including the best modern appliances, capable of making all the steel required and of finishing it in accordance with the contract, and the bidder to whom contract is awarded must execute the same, with good and sufficient sureties for the faithful performance thereof, within twenty days after receiving written notice of acceptance of proposal.

The right is reserved to waive informalities, and to reject any or all bids.

Envelopes containing proposals should be marked "Proposals for 8-inch, 10-inch, and 12-inch steel gun forgings," and be addressed to "The Chief of Ordnance, U. S. Army, Washington, D. C."

Copies of the advertisement, of these instructions to bidders, of the specifications, and of the drawings, must accompany and form part of proposals.

Contract for the manufacture of these forgings will stipulate that if the sets of forgings are not delivered at the proposed times, there will be imposed on the contractor a penalty of two-tenths of a cent per pound per month on the price of each set of forgings for each month of delay in delivery. Part of a month, or the time allowed, under paragraph 13, Part I, of the specifications, to replace finally rejected forgings, not to be considered.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

SPECIFICATIONS GOVERNING THE MANUFACTURE AND INSPECTION OF STEEL FOR CANNON, PRESCRIBED BY THE ORDNANCE DEPARTMENT, U. S. ARMY.

PART I.—GENERAL SPECIFICATIONS.

1. *Metal.*

The metal used shall be low steel, melted by the open-hearth process, and cast into suitable ingots at the works of the contractor. For special purposes and for some small parts crucible steel shall be used when required.

2. *Marking forgings during manufacture.*

The manufacturers shall devise and use plans for marking forgings, pieces for forgings cut from ingots, etc., which shall determine with certainty that end or part of the forging, piece, etc., which was nearest to the top of the ingot as cast, and in case more than one piece is cut from any one ingot, the relative positions of the several pieces in the ingot, and which shall in all cases assure the identification of the forging, piece, etc., with the ingot from which it was made or cut. They shall also determine with certainty the weight of metal cut from the top and from the bottom of each ingot used.

3. *Condition of material when delivered.*

All the forgings shall be rough finished, except when, for some parts of breech mechanism, it is specifically stipulated that smooth forgings are required; they shall conform strictly to the dimensions shown on the drawings accompaning the contract. The United States requires sound and reliable material, and the pieces shall be free from seams, cracks, sand, slag, folds, or other defects.

4. *Allowance of metal for tests.*

The manufacturers shall always allow, without cost to the United States, sufficient additional length or size to the pieces to furnish the test specimens required. If no particular part of the piece is designated for the specimens, the instructions of the senior inspector shall be followed.

5. *Metal for manufacturers' tests.*

Any metal required by the manufacturers for their own mechanical tests at the various stages of manufacture shall be provided for in additional length or size of the pieces over that required by the United States for the tests of acceptance, and in no case, unless by special authorization of the senior inspector, shall the manufacturers use for their own tests any of the metal or length of piece required by the United States.

6. *Test of specimens.*

If the manufacturers possess a reliable testing machine, and if the results obtained with such testing machine are found to be comparable with those obtained with the United States testing machine, at Watertown Arsenal, then the Government specimens required shall be tested by the manufacturers in such manner as shall be prescribed by the United States and in the presence of the inspector; and the inspector shall be furnished with the original notes of the several tests that they may be worked up in his office. Tests made with the United States testing machine at Watertown Arsenal shall always be considered as standard, and any or all specimens may be tested at that place if desired by the United States. The specimens from any one piece shall be tested by the manufacturers within three days of the time they are all finished, except for good and sufficient reasons, to be adjudged as such by the senior inspector. If the manufacturers have no reliable testing machine then all the specimens shall be tested at Watertown Arsenal.

7. *Shipment of specimens.*

All specimens which are to be tested at Watertown Arsenal, excepting those special additional specimens taken by the United States for information, shall be sent to that place by the manufacturers, by express, at their own expense. All specimens shall pass through the senior inspector's hands for inspection and record.

8. *Cost of testing specimens.*

All tests made by the manufacturers shall be without cost to the United States. If tests are made at Watertown Arsenal, then the actual cost of testing and recording specimens shall be charged to the manufacturers.

9. *Reports of tests.*

Summaries of the results of test of specimens made at Watertown Arsenal will be furnished the manufacturers for their information, but shall be regarded as strictly confidential prior to their publication by the Government.

10. *Provisional acceptance.*

Pieces which have filled the requirements of manufacture, which are accepted as to physical qualities, which are satisfactory as to dimensions, and which show no defects, shall be received by the United States provisionally, but the manufacturers shall hold themselves liable to promptly replace any piece which may be condemned at any time during machine finishing for any developed defect.

11. *Delivery.*

A piece shall be considered *delivered* when it is received provisionally by the United States. The manufacturers shall place such pieces, without charge, on board cars, where they can be taken up by a convenient shipping line, for transportation by the United States.

12. *Weight of delivered pieces.*

The weight of all pieces shall be determined in the inspector's presence on reliable and accurate scales, which the inspector may verify at any time. The weight should closely correspond with the calculated weight, assuming a cubic inch of steel to weigh 0.285 of a pound; should there be any great variation, and the inspector can not accurately check the weight, then the calculated weight at the required rough finished dimensions shall be taken as correct.

13. *Time allowed to replace pieces not accepted or rejected.*

If a piece is not accepted on account of unsatisfactory physical qualities shown by the results of test of the first set of specimens presented, the manufacturer shall be allowed six weeks in the case of tubes and jackets for cannon of 8 inches caliber and over, and four weeks in the case of all other pieces, from the date of notification of non-acceptance, in which to present additional specimens, if additional treatment or testing is allowed.

If the manufacturers desire to present additional specimens they shall, within three days from the date they are informed of non-acceptance, notify the senior inspector to that effect. If such notification is not received within that time, or if the manufacturers are informed they can not re-treat or re-test the piece, they shall proceed to replace it.

If a piece is finally rejected at the manufacturers' works on account of unsatisfacory physical qualities or dimensions, or on account of defects, or at any time after elivery on account of defects, then the manufacturers shall be allowed six months n the case of tubes and jackets for cannon of 8 inches caliber and upwards; four nonths in the case of trunnion hoops for cannon of over 8 inches in caliber, and also n the case of tubes and jackets for cannon below 8 inches in caliber, excepting field alibers; three months in the case of tubes for field calibers, and trunnion hoops for annon of 8-inch caliber, and two months in the case of all other pieces, from the late of notification of rejection, in which to replace the rejected piece, and to preent the first set of specimens from the new piece.

14. *Use of rejected pieces.*

Pieces which are rejected may with the approval of the senior inspector be used or other pieces of smaller dimensions, but such smaller pieces made from a rejected iece must always be subjected to the prescribed tests.

15. *Additional specimens required.*

Any special additional test specimens required by the United States for information r experiment shall be furnished by the manufacturers at actual cost of labor of prepration, with 10 per centum added for profit, and to cover wear, etc., of tools.

16. *Board to determine the gravity of defects.*

If a piece is condemned at any time for defects the manufacturers may, with the pproval of the Department, submit the piece for the inspection of a board of three officers of the Ordnance Department, and the decision of said board, subject to the approval of the Chief of Ordnance, shall govern as to its acceptance or rejection; and the manufacturers may have a representative appear before said board.

If any piece is finally rejected by said board, or if the manufacturers acknowledging the gravity of the defect submit to the decision of the condemning inspector, then, if the piece has been shipped by the United States from the manufacturers' works, the manufacturers shall pay the cost of shipping the rejected piece back to their works if they desire it shipped back, and they shall prepay the cost of shipping a piece made to replace the rejected piece to the place of rejection.

17. *Changes in drawings.*

The dimensions shown on the drawings accompanying contracts shall be always subject to such changes as the United States may deem advisable, which do not materially affect the cost of manufacture per pound, or do not decrease the percentage of profit to the manufacturers; and any changes which do materially affect the cost of manufacture per pound, or do decrease the percentage of profit to the manufacturers, shall be paid for at a fair price, to be determined by the contracting parties.

18. *Payments.*

When contracts require the delivery of pieces for the fabrication of more than one kind or caliber of cannon, or more than one set of pieces for a particular caliber, then payment for each set of pieces for each kind or caliber, or for each set for a particular caliber, shall be made the manufacturers on the delivery of each set of pieces, complete, less 5 per centum to be retained by the United States until the completion of the whole contract, or of all the pieces for a particular caliber.

Payments shall be made on bills approved by the proper officers in the manner prescribed by law and regulations.

19. *Liability of sureties.*

A contract for the manufacture of material for cannon shall be considered completed so far as the liability of the sureties is concerned only when all the pieces to be delivered under said contract have been so far machine finished as to preclude the possibility of the final rejection of any one of said pieces.

20. *Drawings and blank forms.*

All necessary drawings shall be provided by the manufacturers, and any copies of drawings furnished by the United States, or any working drawings made by the manufacturers, shall be approved by the senior inspector before they are issued for use at the works. All drawings furnished by the United States shall be considered confidential, and for the use of the manufacturers in the prosecution of the Government work only. All blank forms which may be necessary for the expeditious manufacture of the material, or to facilitate the transaction of business between the senior inspector and the manufacturers, shall be furnished by the manufacturers.

21. *Inspection of the manufacture.*

The manufacture of material for ordnance constructions shall be open to inspection in all its details by the officers and employés of the Ordnance Department assigned to duty for that purpose, and shall receive the approval of the senior inspector at the works, or such one of his assistants as he may designate, at all its stages.

22. *Information and assistance to be given inspectors.*

That the requirements of paragraph 21 may be carried out, the manufacturers shall, before commencing the work under any order or contract, inform the senior inspector of their general plans; and during the progress of the work they shall inform him of the chemical composition of each and every ingot, part of ingot or casting, which they propose to use, together with a statement of its casting, size, and condition; they shall inform him, or such of his assistants as he may designate, of the time at which each operation connected, either directly or indirectly, with the manufacture is to take place, and shall give him such notification as may be required to insure his witnessing any particular part of an operation which he may specify; they shall furnish him with a copy of the results of all chemical analyses and mechanical tests made at their works upon any piece under fabrication or in any way connected with the material to be furnished; they shall provide all necessary labor, and allow the use of the necessary tools and implements for the assistance of the senior inspector and his assistants in the performance of any of their duties, and they shall provide within their works suitable and satisfactory office room for instruments, drawings, books, etc., which may be used exclusively by the senior inspector and his assistants.

The officers and employés referred to in paragraph 21 shall have free access at all times to all parts of the manufacturers' works. The details of the operations carried on at the works will be considered confidential so far as the manufacturers may desire.

PART II.—FOR TUBES AND JACKETS.

1. *Size of ingot.*

Ingots for tubes shall have an area of cross-section in that part of the ingot used for the tube forging at least four times as great as the maximum area of cross-section of the rough forging, except that for tubes for cannon of 12 inches caliber and upward the area of cross-section of that part of the ingot used for the tube forging shall be at least three and one-half times as great as the maximum area of cross-section of the rough forging; the ingots for jackets shall have an area of cross-section in that part of the ingot used for the jacket forging at least three and one-half times as great as the maximum area of cross-section of the rough forging, except that for jackets for cannon of 12 inches caliber and upward the area of cross-section of that part of the ingot used for the jacket forging shall be at least three times as great as the maximum area of cross-section of the rough forging; and the ingots for lining tubes shall have an area of cross-section in that part of the ingot used for the lining-tube forging at least six times as great as the maximum area of cross-section of the rough forging. If bored ingots are used then the wall of the ingot shall be reduced by forging at least as much as to one-half of its original thickness.

2. *Part of ingot to be used.*

Only so much of any ingot shall be used for tubes and jackets as shall remain after at least 6 per centum of the total weight of the ingot has been cut from the bottom of the ingot, and at least 30 per centum from the top.

3. *Sizes of rough forgings.*

Rough forgings shall have only such allowance of metal over the diameters required in the rough-finished piece as will insure the removal of all surface imperfections in rough finishing.

4. *Treatment.*

s and jackets shall, if desired by the United States, be annealed at a high heat ıfter forging, or after rough finishing, and before oil-tempering. This heat at least as high as that at which the pieces are subsequently to be heated for pering.

›ieces shall, after rough boring and turning, be oil-tempered, and subsequently ›d or tempered at a lower temperature than that of the previous operation.

5. *Oil-tempering.*

s and jackets shall generally be heated for oil-tempering vertically, and as as possible; shall be immersed in the tempering fluid in the direction of their such a manner and with such arrangement that a current of the fluid will rough the bore; and the operation shall always be performed on the whole of ɔe, never on a part only.

6. *Annealing after oil-tempering.*

s and jackets shall be heated for annealing as evenly as possible, and the oper- ›all always be performed on the whole of the piece, never on a part only; but necessary from the conditions in any case to vary the degree of the heat at s, this variation must be uniform from one end to the other.

γ operation of tempering or annealing must be witnessed by the senior in- , or such of his assistants as he may designate, and if unsatisfactory in any ;empering or re-annealing shall be ordered in his discretion.

7. *Straightening.*

ı, after treatment, pieces are found to be bent or warped to such an extent as er straightening under the press or hammer necessary they shall be heated for ›ration, and the straightening shall be followed by retreatment. Tubes and when delivered shall be straight and true, free from warp or bend, the ex- ›eing truly concentric with the bore.

8. *Number, form, and position of test specimens.*

ıtem of all test specimens shall, if possible, be taken within the finished in nd exterior surfaces of the piece prolonged.

ential test specimens shall be furnished from each tube and jacket, as specified 'ollowing table, No. I:

TABLE No. I.

Caliber of cannon.	Designation of piece.	Kind of test specimen.	Number of specimens from—		Size of specimens.		Minimum distance of axis from end of forging.
			Breech end.	Muzzle end.	Length of stem.	Diameter of stem.	
					Inches.	Inches.	Inches.
cannon of all calibers ..	Tube ...	Tensile ...	2	2	2.0	0.505	1.15
	Jacket..	...do	2 or	2	2.0	0.505	1.15
cannon of all calibers..	Tube ...	...do	2	2	3.0	0.564	1.25
	Jacket..	...do	3	3	3.0	0.564	1.25
oast cannon of 8-inch cali- , and upward, to 12-inch ber.	Tube ...	...do	3	3	3.0	0.564	1.50
	Jacket..	...do	4	4	3.0	0.564	1.50
oast cannon of 12-inch ber and over.	Tube ...	...do	4	4	3.0	0.564	1.50
	Jacket..	...do	4	4	3.0	0.564	1.50

'ith screw-ends, as required.

9. *Physical qualities.*

Each of the test specimens should show physical qualities given in the following table, No. II, which the manufacturer shall aim to obtain:

TABLE No. II.

Caliber of cannon.	Designation of piece.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.
		Pounds.	*Pounds.*	*Per cent.*
Field cannon of all calibers	Tube Jacket	46,000 50,000	86,000 93,000	22 19
Siege cannon of all calibers	Tube Jacket	46,000 50,000	86,000 93,000	20 18
Sea-coast cannon of 8-inch caliber	Tube Jacket	46,000 50,000	86,000 93,000	19 17
Sea-coast cannon of 10-inch caliber and over.	Tube Jacket	46,000 48,000	86,000 90,000	19 17

The forgings shall, however, be accepted as to physical qualities provided no one of the specimens shows results in any particular below the figures given in the following table, No. III:

TABLE No. III.

Caliber of cannon.	Designation of piece.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
Field cannon of all calibers	Tube Jacket	42,000 46,000	78,000 86,000	20 17	35 30
Siege cannon of all calibers	Tube Jacket	42,000 46,000	78,000 86,000	18 16	30 27
Sea-coast cannon of 8-inch caliber.	Tube Jacket	42,000 46,000	78,000 85,000	17 16	30 27
Sea coast cannon of 10-inch caliber and over.	Tube Jacket	42,000 44,000	78,000 83,000	17 16	30 27

Except that for the calibers and pieces enumerated below, one, and only one, specimen from each end may be in any one particular lower in its qualities than the figures given in Table No. III, but must not be, in that particular, lower than the figures given in the following table, No. IV:

TABLE No. IV.

Caliber of cannon.	Designation of piece.	Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.	Contraction of area.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
Sea-coast cannon of 8-inch caliber.	Jacket	44,000	83,000	14	32
Sea-coast cannon of 10-inch and over.	Tube Jacket	40,000 42,000	75,000 80,000	15 13.5	25 20

In addition to the tensile tests prescribed, the tubes and jackets shall be submitted to a powder test, or percussive hydraulic test if desired by the United States, with an interior pressure a little (about 1,000 pounds) less than their elastic resistance. No weakness or defect should be developed by these tests; and the manufacturers shall detach rings for mandrel or initial tension tests when in special cases they are notified that such rings are desired.

These additional tests will be made under the supervision of the Ordnance Department, and any extra expense incurred by the manufacturers will be paid for as provided in paragraph 15, Part I.

10. *Re-testing.*

If the piece fails to fill the physical requirements of these specifications at either or both ends, an additional set or sets of specimens may be submitted for test, but in such case no one specimen should show results below the figures given in table No. III. If a piece fails to fill the requirements on this second presentation it shall be finally rejected, except when the senior inspector may recommend and the Chief of Ordnance authorize further testing.

11. *Re-treatment.*

When a piece fails to fill the physical requirements of these specifications and the manufacturers re-anneal, or retemper and re-anneal it, complete tests of both ends shall be made, and the previous tests shall not be considered in deciding upon the acceptance or rejection of the piece.

PART III.—FOR HOOPS.

1. *Part of ingot to be used.*

Only so much of any ingot shall be used for hoops as shall remain after at least 5 per centum of the total weight of the ingot has been cut from the bottom of the ingot, and at least 28 per centum from the top.

2. *Size of forgings.*

Cylindrical hoops may be either forged or rolled, but will be rolled whenever practicable. The allowance of metal over the rough-finished diameters shall be as slight as possible, especially if the hoops are to be treated as they come from the forge or rolls, and without being machined.

The inspector shall, in his discretion, require the re-working of any hoop on which there is an excessive allowance of metal in any part or throughout, or shall require the removal of the surplus metal by machining.

Trunnion-hoops shall vary as little as possible from the rough-finished diameters, and especially the rough-finished dimensions in the vicinity of the rim-bases, and any surplus metal shall be removed before treatment.

3. *Treatment.*

All hoops shall, if desired by the United States, be annealed at a high heat before oil-tempering. This heat will be at least as high as that at which the hoops are to be subsequently oil-tempered. The hoops shall then be oil-tempered, and subsequently annealed or tempered at a lower temperature than that of the previous operation.

4. *Oil-tempering.*

All hoops shall be heated for oil-tempering as evenly as possible, and shall be immersed in the tempering fluid in the direction of their axes, and the operation shall be performed on the whole of the piece, never on a part only.

5. *Annealing after oil-tempering.*

All hoops shall be heated for annealing as evenly as possible, and the operation shall always be performed on the whole of the piece, never on a part only.

Every operation of tempering or annealing must be witnessed by the inspector, or such of his assistants as he may designate, and if unsatisfactory in any way, retempering or re-annealing shall be ordered in his discretion.

6. *Representative treatment.*

Whenever the treatment to which hoops are subjected is to be representative, *i. e.*, when two or more hoops are treated together in the final annealing, and all are not to be tested, then that operation must be witnessed by the inspector, or one of his assistants, or the tests made of one hoop will not be taken to represent the other or others, and in all such cases of representative treatment the proposed disposition of the hoops for treatment must receive the approval of the inspector before the operation is commenced.

7. *Number, position, and form of test specimens.*

The stem of all test specimens shall, if possible, be taken within the finished interior and exterior surfaces of the hoop prolonged.

Tangential test specimens shall be furnished from each trunnion-hoop, as specified in the following table, No. V:

TABLE NO. V.

Caliber of cannon.	Number of test specimens.		Size of specimens.		Minimum distance of axis from end of hoop.
	Breech end.	Muzzle end.	Length of stem.	Diameter of stem.	
			Inches.	*Inches.*	*Inches.*
Field-cannon of all calibers	2 or 2		2	0.505	1.15
Siege-cannon of all calibers	3 or 3		3	0.564	1.25
Sea-coast guns of 8 inches caliber and over	4 or 4		4	0.564	1.25
Mortars of 8 inches caliber and over	3 or 3		4	0.564	1.25

All with screw-ends as required.

Tangential test-specimens shall be furnished from cylindrical hoops, as specified in the following table, No. VI:

TABLE NO. VI.

Rough-finished size of hoops.	Number of test specimens.			Size of specimens.		Minimum distance of axis from end of hoop.
	From breech end.	From muzzle end.	From hoop.	Length of stem.	Diameter of stem.	
				Inches.	*Inches.*	*Inches.*
Not more than 8″ inside diameter. Not more than 30″ long	......	......	1	2	9.505	1.15
Not more than 8″ inside diameter. More than 30″ long	1	1	......	2	0.505	1.15
More than 8″ inside diameter. Not more than 16″ inside diameter. Not more than 30″ long	......	......	2	3	0.564	1.25
More than 8″ inside diameter. Not more than 16″ inside diameter. More than 30″ long	2	2	......	3	0.564	1.25
More than 16″ inside diameter. Not more than 34″ inside diameter. Not more than 26″ long	......	......	3	4	0.564	1.25
More than 16″ inside diameter. Not more than 34″ inside diameter. More than 26″ long	3	3	......	4	0.564	1.25
More than 34″ inside diameter. Not more than 25″ long	......	......	4	4	0.564	1.25
More than 34″ inside diameter. More than 25″ long	4	4	......	4	0.564	1.25

All with screw-ends as required.

8.—*Physical qualities.*

he test specimens should show the mean physical qualities given in the following le, No. VII, as a minimum:

Table No. VII.

Test specimens—	Size of specimens.		Elastic limit per square inch.	Tensile strength per square inch.	Elongation after rupture.
	Length of stem.	Diameter of stem.			
	Inches.	*Inches.*	*Pounds.*	*Pounds.*	*Per cent.*
For trunnion-hoops	2	0.505	50,000	90,000	18
Do	3	0.564	50,000	90,000	15
Do	4	0.564	50,000	90,000	13
For cylindrical hoops	2	0.505	50,000	90,000	18
Do	3	0.564	53,000	93,000	15
Do	4	0.564	53,000	93,000	13

rovided that for trunnion hoops, one specimen may be, in any one particular, ow the figures given in Table No. VII, but not lower than 48,000 pounds per square n in elastic limit, 88,000 pounds per square inch in tensile strength, or 1 per cent. than given in elongation after rupture; and provided, further, that for cylindri- hoops, when three or four specimens are taken, one of those specimens, or one n each end, and no more, may be in any one particular below the figures given in le No. VII, but not lower than 50,000 pounds per square inch in elastic limit, 90,000 uds per square inch in tensile strength, or 12 per cent. in elongation after ture.

ut for cylindrical hoops the inspector may arrange with the manufacturer, before work is done, to make the treatment representative when more than one hoop is le from an ingot—provided, that at least one-half of the total number of hoops le from any one ingot shall be tested, and that the inspector shall designate ch one or ones of the hoops shall be tested. In case of such representative treat- it the rejection of the tested hoop shall carry with it the rejection of the hoop or ps represented by such tests, unless it shall happen that there be on a non-tested p sufficient extra metal to allow its test to the satisfaction of the inspector, in ch case the non-tested hoop shall be tested, and its acceptance or rejection shall end on the results of the test of the specimens taken from it. The inspector shall n time to time require a specimen or specimens, not exceeding the number re- red for such hoops, to be taken from any non-tested hoop and non-tested end runnion hoops, to judge of the uniformity of treatment.

9. *Re-testing.*

any hoop fails to fill the physical requirements of these specifications at either or h ends, an additional set or sets of specimens, or a number less than originally re- red, in the discretion of the inspector, may be submitted for test, in which case the or sets of specimens must fill the requirments as to physical qualities, and each of reduced number of specimens must show qualities as high as the mean qualities ired. A hoop failing to pass on the submission of additional specimen shall be lly rejected, except where the senior inspector recommends, and the Chief of Ord- ce authorizes, further testing.

10. *Re-treatment.*

hen a hoop fails to fill the physical requirments of these specifications, and the ufacturers re-anneal, or re-temper and re-anneal it, complete tests shall be made ne or both ends, as the case may be. Representative re-treatment shall be con- ted under the conditions, restrictions, and limitations prescribed for original rep- ntative treatment.

11. *Definition of hoop.*

he term cylindrical hoop used in these specifications shall be construed to mean hose forgings which are to be used over a tube or jacket in constructing a gun, whatever name they may be designated, either as hoop, ring, sleeve, etc., and also bushings for the breech.

PART IV.—FOR PARTS OF BREECH MECHANISM.

1. *Part of ingots to be used.*

Only so much of any ingot shall be used for breech mechanism forgings as shall remain after at least 5 per centum of the total weight of the ingot has been cut from the bottom of the ingot and at least 28 per centum from the top.

2. *Size of forgings.*

Parts of breech mechanism, excepting those expressly required as smooth forgings, shall be rough-finished before treatment; but the inspector may, in his discretion, if the conditions warrant it, waive this requirment entirely, or may only require the removal of any excessive allowance of metal in places by machining; parts, however, which are to be used, and which are shown on the drawings bored or pierced, shall always be bored or pierced before treatment.

3. *Treatment.*

Parts of breech mechanism, or such of them as may be desired by the United States, shall be annealed at a high heat before oil-tempering. This heat will be at least as high as that at which the parts are to be subsequently oil-tempered. The parts shall then be oil-tempered and subsequently annealed or tempered at a lower temperature than that of the previous operation.

4. *Oil-tempering.*

Parts of breech mechanism shall be heated for oil-tempering as evenly as possible and immersed in tempering fluid as required; the operation shall always be performed on the whole of the piece, never on a part only.

5. *Annealing after oil-tempering.*

Parts of breach mechanism shall be heated for annealing as evenly as possible, and the operation shall always be performed on the whole of the piece, never on a part only.

Every operation of tempering and annealing must be witnessed by the inspector or such of his assistants as he may designate, and if unsatisfactory in any way, retempering or re-annealing shall be ordered, in his discretion.

6. *Representative treatment.*

The parts of breech mechanism of the same kind made from the same ingot shall, as much as possible, be treated together, and specimens for test taken from one or more of the pieces to represent the whole, as specified in Table No. VIII. Every operation of this kind must be witnessed by the inspector or one of his assistants, or the tests of one piece will not be taken to represent the other or others not tested, and in all such cases the proposed disposition of the pieces for the final annealing must be approved by the inspector before the operation is commenced.

The acceptance or rejection of the tested piece shall, in such case, carry with it the acceptance or rejection of all the other pieces represented by such tests, except that in case of non-acceptance or rejection, when there happens to be on any of the other pieces sufficient metal to allow its being tested to the satisfaction of the inspector, it shall be tested and passed upon separately, or in case there are several pieces represented and no extra metal for test specimens, one or more of these pieces may be cut up for test to represent the remaining ones, if satisfactory to the inspector. In all cases of representative treatment the manufacturers shall arrange with the inspector the details of the fabrication, and the inspector shall designate which one or ones of the pieces shall be tested.

7. *Number, position, and form of test specimens.*

The stem of all specimens shall, if possible, be taken within the finished exterior and interior surfaces of the piece prolonged, or otherwise they shall be taken just outside the rough-finished lines of the piece. The axis shall, if possible, always be at least 3 inches from axis of the forging.

Test specimens shall be furnished from parts of breech mechanism as specified in the following table, No. VIII.

TABLE No. VIII.

Name of part.	Caliber of cannon.			Size of specimen.		Minimum distance of axes from end of piece.
	Field-cannon of all calibers.	Siege-cannon of all calibers.	Sea-coast cannon of 8 inches caliber and over.	Length of stem.	Diameter of stem.	
				Inches	*Inches.*	*Inches.*
reech-block	One from every fifth.	One from every third.	....	2.0	0.505	1.15
	....	....	Two from every second.	3.0	0.564	1.25
pindle	One from stem of every fifth.	One from stem of every third.	....	2.0	0.505	
	....	....	Two from held of every second.	3.0	0.564	1.25
ever handles, breech-plates and face-plates	One from every twelfth.	One from every fifth.	....	2.0	0.505	
	....	....	One from every second.	3.0	0.564	
as check cups and gas-check rings.	One from one additional forging for test. To be made for each ten.	One from one additional forging for test. To be made for each six.	....	2.0	0.505	0.50
	....	....	Two from one additional forging for test. To be made for each four.	3.0	0.564	0.75
lock carriers	One from every twelfth.	One from every third.	....	2.0	0.505	0.75
inge-pins, rollers and bars for securing pins	One from one additional forging for test. To be made for each twenty-five.	One from every fifth.	....	2.0	0.505	
	....	....	One from every third.	3.0	0.564	

All with screw-ends, as required.

When one (or more) specimen is required from each ten (or other number of) forg- gs, one specimen will also be required for any less number of forgings, and at least e forging from each ingot and kind of forging shall be tested.

8. *Physical qualities.*

The test specimens must show the physical qualities given in the following table, . IX, as a minimum.

TABLE No. IX.

Name of part.	Size of specimen.		Elastic limit.	Tensile strength.	Elongation after rupture.
	Length of stem.	Diameter of stem.			
	Inches.	*Inches.*	*Lbs. per sq. inch.*	*Lbs. per sq. inch.*	*Per cent.*
Breech-block spindles, hinge-pins, and rollers	2.0	0.505	46,000	86,000	18.0
	3.0	0.564	46,000	86,000	16.0
Lever-handles, breech-plates, face plates, block-carriers, and nuts	2.0	0.505	40,000	75,000	20.0
	3.0	0.564	40,000	75,000	18.0
Gas-check cups, gas check rings, and bars for securing pins	2.0	0.505	70,000	125,000	12.0
	3.0	0.564	70,000	125,000	10.0

9. *Additional tests.*

If any piece separately tested fails to fill the physical requirements of these specifications, an additional set of specimens may be submitted for test. Failing to fill the physical requirements on this additional submission, the piece shall be finally rejected, except in special cases.

When tests are representative, re-testing shall be subject to the conditions, requirements, and limitations of paragraph 6 of the specifications for parts of breech mechanism.

10. *Additional treatment.*

When a piece fails to fill the physical requirements of these specifications, and re-annealing, or retempering and re-annealing, is resorted to, complete tests shall be made, and the previous tests shall not be considered in deciding upon the acceptance or rejection of the piece. Representative re-treatment shall be conducted under the conditions, restrictions, and limitations prescribed for original representative treatment.

11. *Parts required as rough forgings.*

Those parts of breech mechanism required to be delivered simply as smooth forging or as simple castings, and without any requirement as to physical qualities, shall be made with great care, shall conform as nearly as practicable to the rough dimensions shown on the drawings, and shall be made of metal satisfactory to the inspector. Such parts shall be annealed after forging or casting, and shall receive no other treatment.

PART V.—GENERAL DUTIES OF INSPECTORS.

Officers and employés of the Ordnance Department assigned to the duty of inspecting material for ordnance constructions will carefully and constantly watch the details of manufacture in all its stages; keep complete records of the manufacture of each piece; decide all minor questions of detail referred to them by the manufacturers that may arise; and, subject to the confirmation of the Chief of Ordnance, accept all material which fairly fills the contract requirements. They will see that the work and treatment at every stage of progress fill the requirements of the specifications and are such that the test of the specimens to be taken will truly represent the piece, and will inform the manufacturers what additional work, treatment etc., seem necessary to satisfy this condition.

Generally speaking, they will not interfere with the means and methods adopted by the manufacturer for executing his work, but will rather pass upon their character as satisfactory or otherwise, and upon the uniformity of the execution.

In designating the position of and in marking test specimens they will be guided by the following instructions:

Test specimens taken from metal to be used in ordnance construction (excepting those taken from billets for wire drawing) will be marked on both ends to show—

(1) The caliber of the cannon for which the metal is intended: 32 for 3.2 inches; 8 for 8 inches; 10 for 10 inches; 12 for 12 inches, etc.

(2) The kind of cannon for which the metal is intended: R for steel rifle; MR for mortar; WR for wire-wound rifle; CIR for cast-iron rifle, etc.

(3) The number of the cannon of the particular caliber and kind: 1, 2, 3, etc.

(4) The part of the cannon for which the metal is intended: T for tube; J for jacket, etc. In the case of cast-iron cannon, or cast-iron bodies for cannon combined of steel and cast-iron, where the specimens are ordinarily taken from the initial tension rings, the abbreviation will be TR, showing that the specimen is from the initial tension ring; and if more than one initial tension ring is taken from either end, the abbreviations TR_2, TR_3, etc., will be used.

(5) The end of the piece from which the specimen is taken: B for breech; M for muzzle.

(6) The direction in which the specimen is taken: T for tangential, or those taken parallel to a tangent at the circumference; L for longitudinal, or those taken parallel to the axis of the cannon; R for those taken radially.

(7) The number of the specimen: 1, 2, 3, etc. The same series of numbers to be used for each end (breech or muzzle) of the piece.

(8) The position with reference to the interior and exterior surfaces of the piece of metal: I for inside specimens, or those taken near the interior surface; O for outside specimens, or those taken near the exterior surface; M for middle specimens, or those taken midway between the interior and exterior surfaces.

(9) The fact that the specimen has been laid off and stamped in the presence of the inspector or his assistant, and that its identity is vouched for; this is indicated by

the inspector's private stamp, the escutcheon of the Ordnance Department, one-quarter of an inch in diameter, on hardened steel.

These marks will appear in the order indicated; those required to indicate the points numbered 1, 2, 3, and 4 (which show from what the specimen is taken) being in one line, the remainder (which show how the specimen is taken) being in a second line just below the first as seen when looking at the end of the specimen. The marks and the inspector's private stamp should always be on the specimen from the time it is laid off until finished, and before they are effaced in one place by any finishing operation must be transferred to some other place in the presence of the inspector or his assistant.

The ring, slice, or piece which is to furnish test specimens, and the forging from which it is to be cut, will each be marked before the cut is taken, and close to the cut, to indicate the points numbered 1, 2, 3, 4, 5, and 9. These marks on forgings should always be on the piece, and before they are effaced in one place by any rough-finishing operation must be transferred to some other place in the presence of the inspector or his assistant.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance U. S. Army.

ORDNANCE DEPARTMENT,
Washington, D. C., September 10, 1888.

PROPOSAL FOR 8-INCH, 10-INCH, AND 12-INCH STEEL GUN FORGINGS.

SOUTH BETHLEHEM, PA., *December* 18, 1888.

The CHIEF OF ORDNANCE U. S. ARMY,
Washington, D. C.:

SIR: In accordance with your advertisement of November 15, 1888, inviting proposals for complete sets of rough-finished, oil-tempered, and annealed steel forgings for 8-inch, 10-inch, and 12-inch guns, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish—

26 sets of forgings for 8-inch guns	at 24 cents per pound.
26 sets of forgings for 10-inch guns	at 26½ cents per pound.
17 sets of forgings for 12-inch guns	at 27½ cents per pound.

We will make deliveries as follows, viz:

First set of 8-inch forgings within eighteen months from date of contract, and after the first delivery will deliver 8-inch forgings at the rate of eighteen sets every twelve months, completing the delivery of all the 8-inch forgings within thirty-five months from date of contract.

First set of 10-inch forgings within thirty-six months from date of contract, and after the first delivery will deliver 10-inch forgings at the rate of twelve sets every twelve months, completing the delivery of all the 10-inch forgings within sixty-two months from date of contract.

First set of 12-inch forgings within thirty-six months from date of contract, and after the first delivery will deliver 12-inch forgings at the rate of six sets every twelve months, completing the delivery of all the 12-inch forgings within seventy months from date of contract; and the United States shall have the right, at any time pending the delivery of 12-inch forgings, to order, at the prices herein bid, similar additional sets of forgings of either of the calibers named, to the extent of $45,000 (more or less) in total price, delivery of such additional sets to be made within one year from date of order therefor.

The sets of forgings to conform in quality to the specifications and in dimensions to the drawings hereto attached and made a part of this proposal.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, of the requirements of the specifications and drawings hereto attached, and of the provisions and requirements of the act of Congress approved September 22, 1888, under which the advertisement is issued, and if it is accepted will, after receiving written notice of such acceptance, enter into contract, within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof, and we have in the United States a suitable plant, including the best modern appliances, capable of making all the steel required and of finishing it in accordance with said contract.

THE BETHLEHEM IRON COMPANY,
Per ROBT. H. SAYRE, [L. S.]
General Manager.

Attest:
ABRAHAM S. SCHROPP,
Secretary.

OFFICE OF THE BETHLEHEM IRON COMPANY,
South Bethlehem, December 18, 1888.

CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In case the United States desires to accelerate the date of commencement of deliveries, the Bethlehem Iron Company hereby agrees to begin the deliveries at the periods and at the prices per pound and per set as below recited.

12-INCH GUNS.

33 months, at 28½ cents per pound, and $39,449.70 per set.
30 months, at 29½ cents per pound, and $40,833.90 per set.
27 months, at 30½ cents per pound, and $42,218.10 per set.
24 months, at 31½ cents per pound, and $43,602.30 per set.
21 months, at 32½ cents per pound, and $14,986.50 per set.
18 months, at 33 cents per pound, and $45,678.60 per set.

10-INCH GUNS.

33 months, at 27½ cents per pound, and $22,419.37 per set.
30 months, at 28½ cents per pound, and $23,234.62 per set.
27 months, at 29½ cents per pound, and $24,049.87 per set.
24 months, at 30½ cents per pound, and $24,865.12 per set.
21 months, at 31½ cents per pound, and $25,680.38 per set.
18 months, at 32 cents per pound, and $26,088. per set.

8-INCH GUNS.

15 months, at 25½ cents per pound, and $10,138.40 per set.
12 months, at 27½ cents per pound, and $10,938.80 per set.
9 months, at 29½ cents per pound, and $11,739.20 per set.

Intervals of deliveries after commencement, on each size, to be about as given in our lowest bid, or as may be arranged between the United States and the Bethlehem Iron Company.

It being also understood that should the United States desire earlier periods of delivery at the respective prices per pound or per set named above, the time shall also for such deliveries begin to run from the date of the contract for said work.

THE BETHLEHEM IRON COMPANY,
Per ROB'T H. SAYRE,
General Manager.

PROPOSAL FOR 8-INCH, 10-INCH AND 12-INCH STEEL GUN FORGINGS.

THE MIDVALE STEEL COMPANY,
Nicetown, Philadelphia, December 18, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In accordance with your advertisement of November 15, 1888, inviting proposals for complete sets of rough-finished, oil-tempered, and annealed steel forgings for 8-inch, 10-inch, and 12-inch guns, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish—

23 sets of forgings for 8-inch guns, at 29 cents per pound.
24 sets of forgings for 10-inch guns, at 30 cents per pound.
14 sets of forgings for 12-inch guns, at 31 cents per pound.

We will make deliveries as follows, viz:

First set of 8-inch forgings within eighteen months from date of contract, and after the first delivery will deliver 8-inch forgings at the rate of four sets every twelve months, completing the delivery of all the 8-inch forgings within eighty-four months from date of contract.

First set of 10-inch forgings within thirty months from date of contract, and after the first delivery will deliver 10-inch forgings at the rate of four sets every twelve months, completing the delivery of all the 10-inch forgings within ninety-nine months from date of contract.

First set of 12-inch forgings within thirty-six months from date of contract, and after the first delivery will deliver 12-inch forgings at the rate of three sets every twelve months, completing the delivery of all the 12-inch forgings within eighty-eight months from date of contract; and the United States shall have the right at any time pending the delivery of 12-inch forgings, to order, at the prices herein bid, similar additional sets of forgings of either of the calibers named, to the extent of $45,000 (more or less) in total price, delivery of such additional sets to be made within one year from date of order therefor.

The sets of forgings to conform in quality to the specifications and in dimensions to the drawings hereto attached and made a part of this proposal.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, of the requirements of the specifications and drawings hereto attached, and of the provisions and requirements of the act of Congress approved September 22, 1888, under which the advertisement is issued, and if it is accepted will, after receiving written notice of such acceptance, enter into contract, within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof, and we will erect in the United States a suitable plant; including the best modern appliances, capable of making all the steel required and of finishing it in accordance with said contract.

CHARLES J. HARRAH, [L.S.]
President Midvale Steel Company.

Attest:
ELLWOOD W. KIMBER,
Secretary.

Article of agreement entered into this 31st day of January, 1889, between The Bethlehem Iron Company of South Bethlehem, in the county of Northampton, State of Pennsylvania, of the first part, and the United States, by Brig. Gen. S. V. Benét, Chief of Ordnance, acting under the direction and by authority of the Secretary of War, for and in their behalf, of the second part.

1st. This agreement witnesseth, that the said Bethlehem Iron Company, for itself and successors, and the said S. V. Benét, for and in behalf of the United States of America, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz:

Under advertisement dated November 15, 1888, the said party of the first part does hereby contract and engage with the said United States to manufacture for the Ordnance Department, U. S. Army—in accordance with said advertisement, instructions to bidders, specifications, and drawings hereto attached and forming part of this contract—the following-described complete sets of rough-finished, oil-tempered, and annealed steel forgings, of American manufacture, for 8-inch, 10-inch, and 12-inch guns at the following prices as specified in their proposal dated December 18, 1888, viz:

Twenty-three sets steel forgings for 8-inch rifles at—

Twenty-seven and one-third cents per pound, if the first set is delivered in twelve months or in less than fifteen months from date of this contract.

Twenty-five and one-third cents per pound, if the first set is delivered in fifteen months or in less than eighteen months from date of this contract.

Twenty-four cents per pound, if the first set is delivered in eighteen months from date of this contract.

The remaining twenty-two sets to be delivered at the rate of eighteen sets every twelve months, after the delivery of the first set until the whole number contracted for is delivered.

Twenty-three sets steel forgings for 10-inch rifles at—

Thirty and one-half cents per pound, if the first set is delivered in twenty-four months or in less than twenty-seven months from date of this contract.

Twenty-nine and one-half cents per pound, if the first set is delivered in twenty-seven months or in less than thirty months from date of this contract.

Twenty-eight and one-half cents per pound, if the first set is delivered in thirty months or in less than thirty-three months from date of this contract.

Twenty-seven and one-half cents per pound, if the first set is delivered in thirty-three months or in less than thirty-six months from date of this contract.

Twenty-six and one-half cents per pound, if the first set is delivered in thirty-six months from date of this contract.

The remaining twenty-two sets to be delivered at the rate of 12 sets every twelve months, after the delivery of the first set until the whole number contracted for is delivered.

Fifteen sets steel forgings for 12-inch rifles at—

Thirty and one-half cents per pound, if the first set is delivered in twenty-seven months or in less than thirty months from date of this contract.

Twenty-nine and one-half cents per pound, if the first set is delivered in thirty months or in less than thirty-three months from date of this contract.

Twenty-eight and one-half cents per pound, if the first set is delivered in thirty-three months or in less than thirty-six months from date of this contract.

Twenty-seven and one-half cents per pound, if the first set is delivered in thirty-six months from date of this contract.

The remaining 12 sets to be delivered at the rate of 6 sets every twelve months after the delivery of the first set until the whole number contracted for is delivered.

It is further stipulated and agreed that the party of the first part will furnish such limited additional forgings as above, and at the prices stated, as the party of the second part may desire, under the present available appropriation.

It is further stipulated and agreed that if the forgings herein contracted for are not delivered by the party of the first part at the latest times specified herein for each caliber, respectively, a penalty of two-tenths of a cent per pound per month on the price of each set of forgings for each month of delay in delivery thereafter shall be imposed on the said party of the first part, and all penalties incurred under this contract shall be off-se', from time to time, against any payment or payments falling due to the said party of the first part; the time allowed under paragraph 13, part 1, of the specifications to replace finally-rejected forgings not to be considered in imposing penalties under this clause of this contract.

If any doubts or disputes arise as to the meaning of anything in this or any of the papers hereunto attached and forming this contract, the matter shall be at once referred to the Chief of Ordnance, U. S. Army, for determination, and the parties of the first part hereby bind themselves to abide by his decision. If, however, the parties of the first part shall feel aggrieved at any decision of the Chief of Ordnance, they shall have the right to submit the same to the Secretary of War and his decision shall be final.

2d. All the forgings herein contracted for shall be delivered by the said party of the first part as before mentioned.

3d. The said party of the first shall indemnify the United States and all persons acting under them for all liability on account of any patent rights granted by the United States which may affect the forgings herein contracted for.

4th. For the forgings herein contracted for, which shall be delivered, inspected, and accepted as aforesaid, there shall be paid by the United States to the said party of the first part, or the successors thereof, on bills in duplicate, made in approved form and duly authenticated by the proper officers of the Ordnance Department, the prices aforementioned in the funds furnished for the purpose by the United States.

6th. Neither this contract nor any interest therein shall be transferred by the said party of the first part to any other party; and any such transfer shall cause the annulment of the contract so far as the United States are concerned. All rights of action, however, to recover for any breach of this contract by the said party of the first part are reserved to the United States.

7th. No member of or delegate to Congress, nor any person belonging to or employed in the military service of the United States is or shall be admitted to any share or part of this contract or to any benefit which may arise herefrom.

Section 5 of this contract was erased by mutual consent before signing.

THE BETHLEHEM IRON COMPANY,
Per ROBT. P. LINDERMAN, [SEAL.]
Vice-President.

S. V. BENÉT, [SEAL.]
Brigadier-General, Chief of Ordnance, U. S. Army.

Attest:
ABRAHAM S. SCHROPP,
Secretary.

NOTE.—All contracts for general supplies should provide that the party of the first part shall furnish to the party of the second part (the United States) such greater or lesser quantities of the articles contracted for as may be required during the fiscal year.

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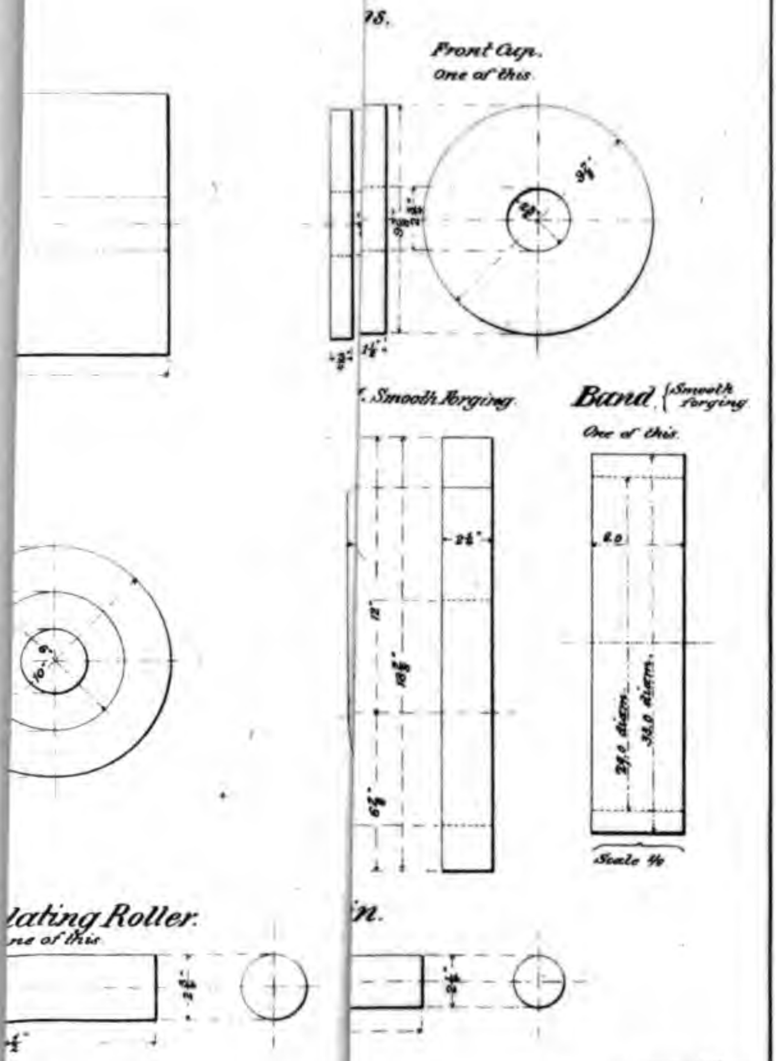

Chas S. Smith
Captain, Ordn Dept., U.S.A.,
Principal Assistant.

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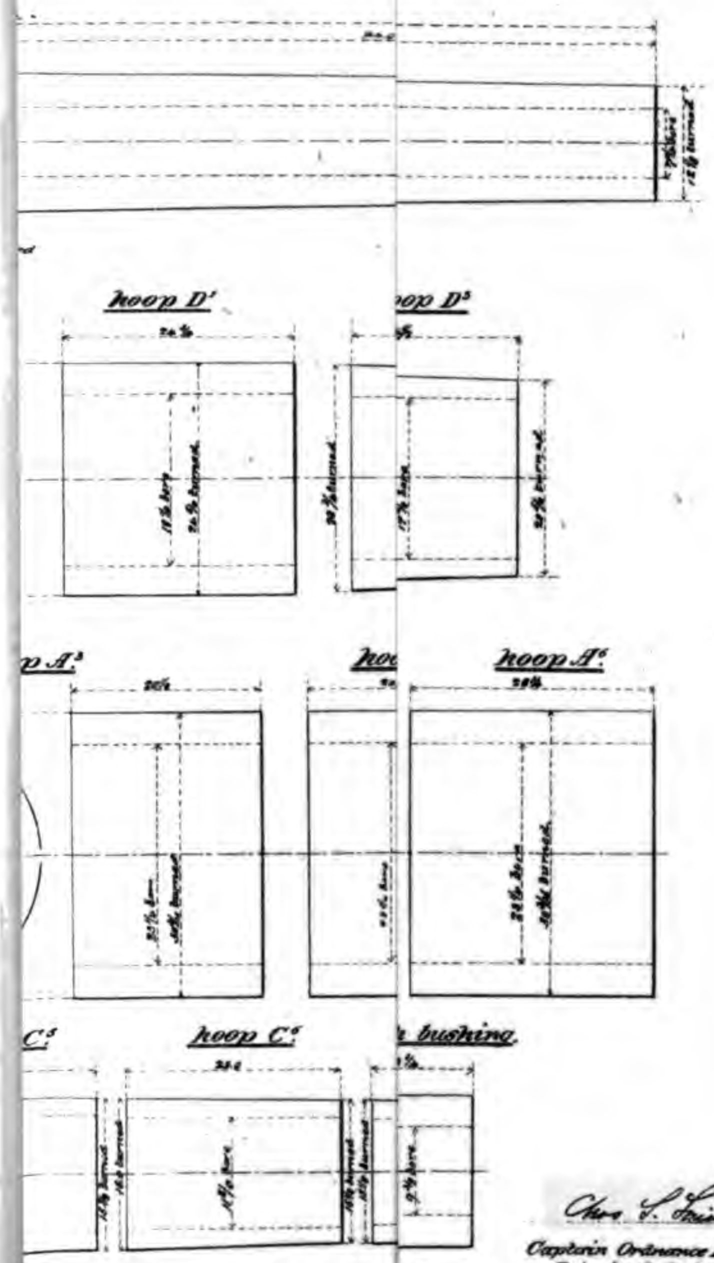

Chas. S. Smith
Captain Ordnance Dept.
Principal Assistant.

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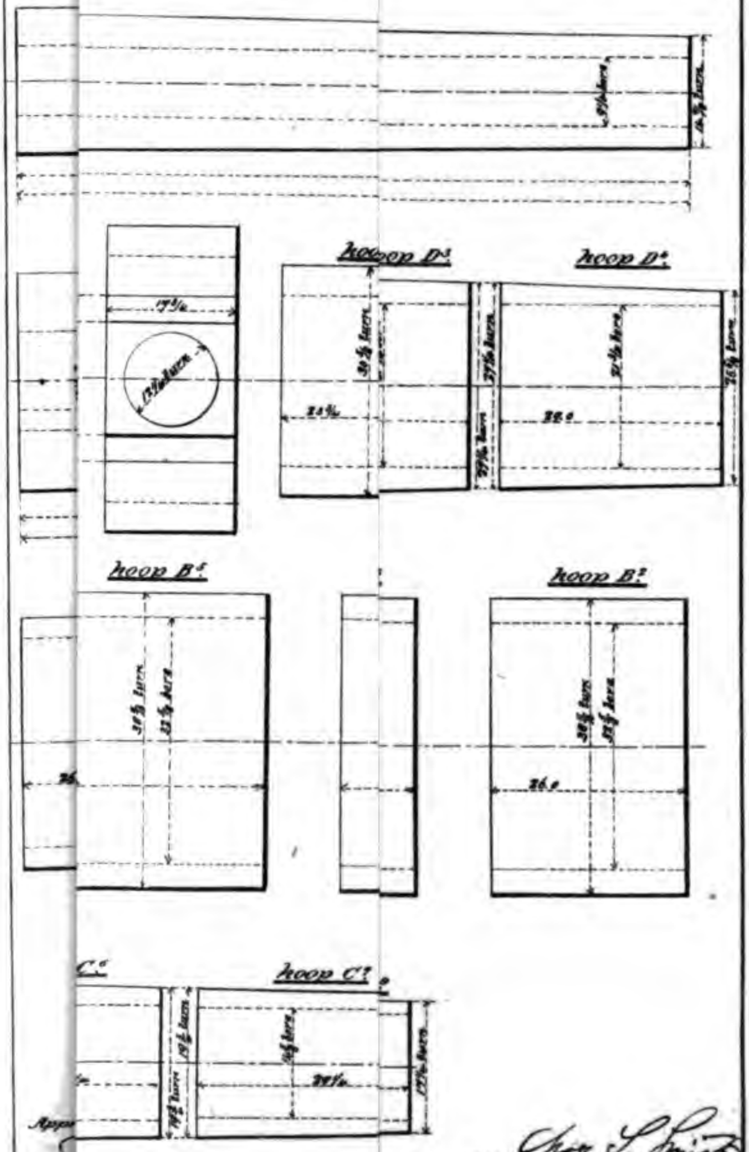

Chas. S. Smith
Captain Ordnance Dept.,
Principal Assistant.

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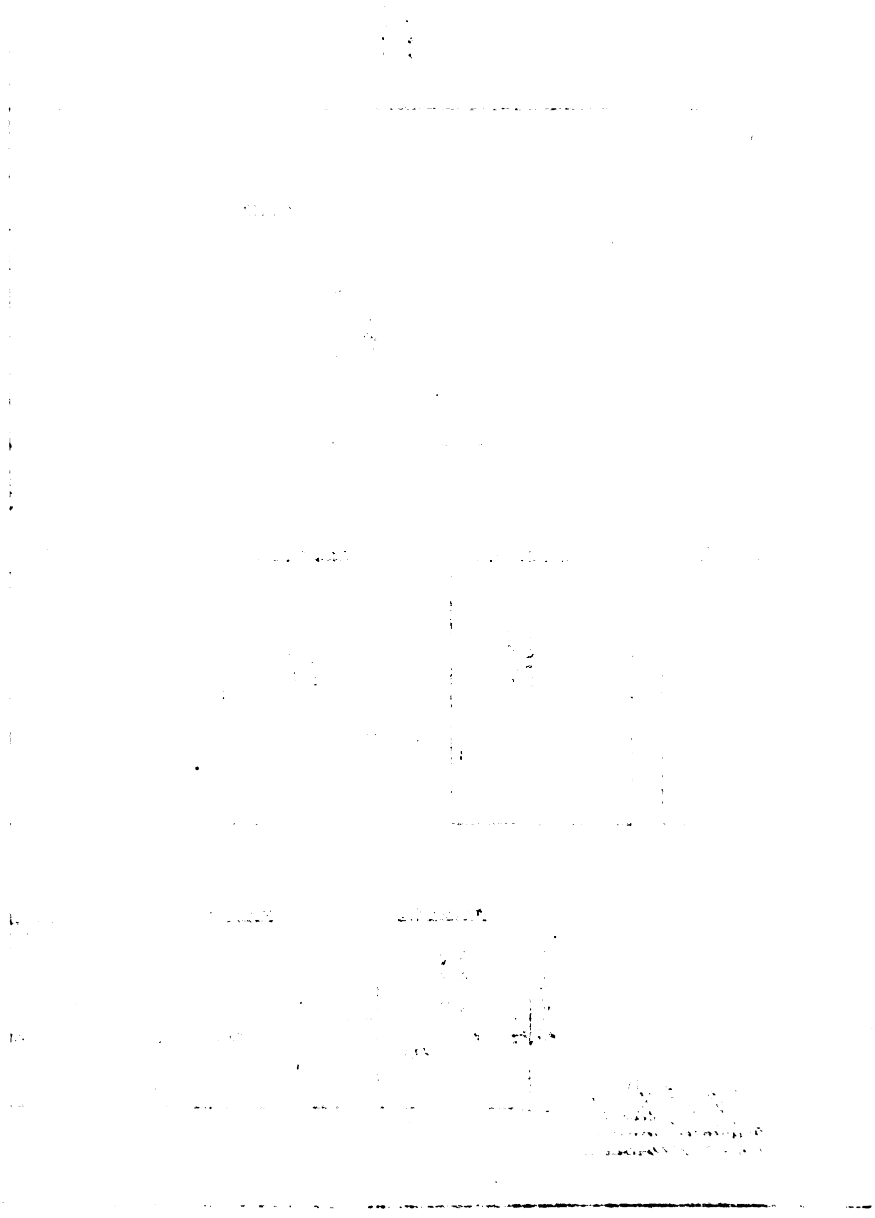

Front Cup
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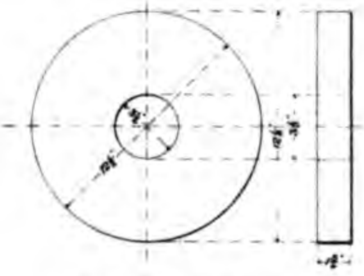

Gas-Check Cups.

Rear Cup
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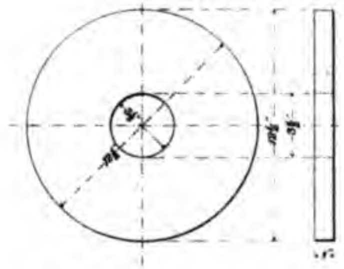

Hinge-Pin.

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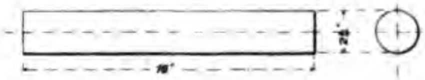

Bar for Securing-Pins.

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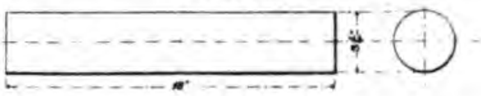

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Chas. S. Smith,
Captain, Ordn. Dept., U.S.A.,
Principal Assistant.

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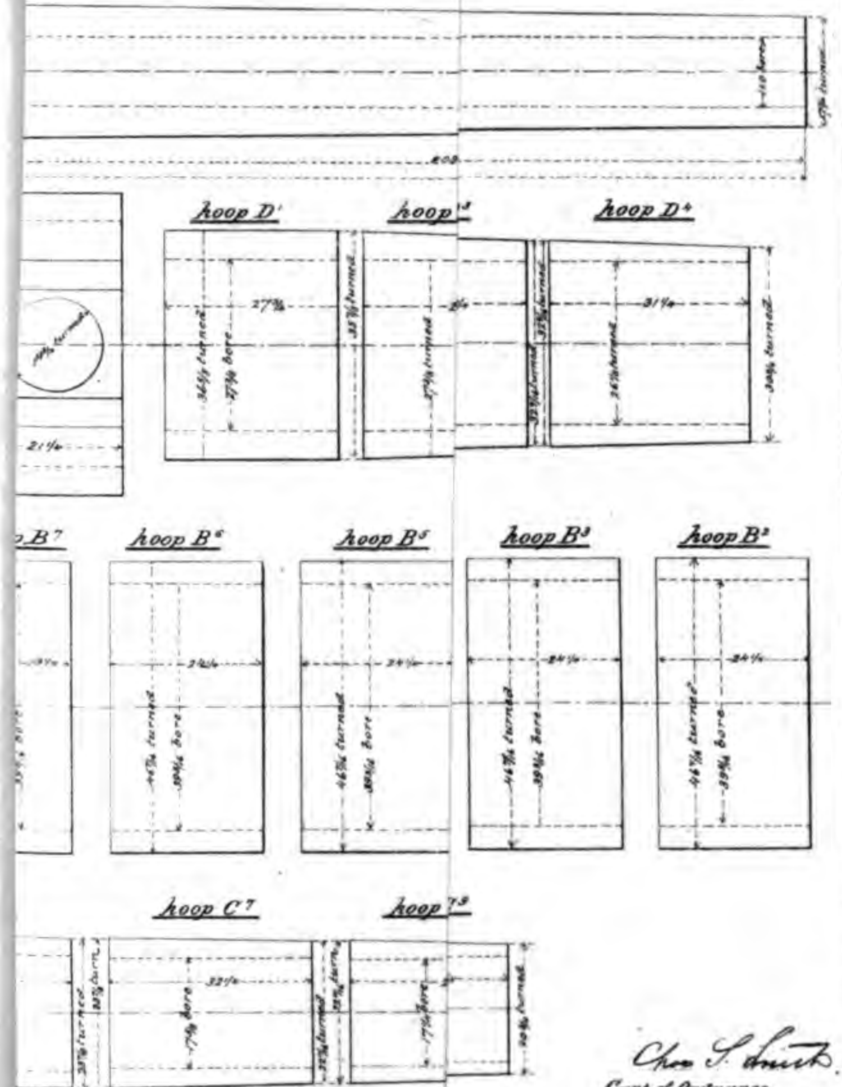
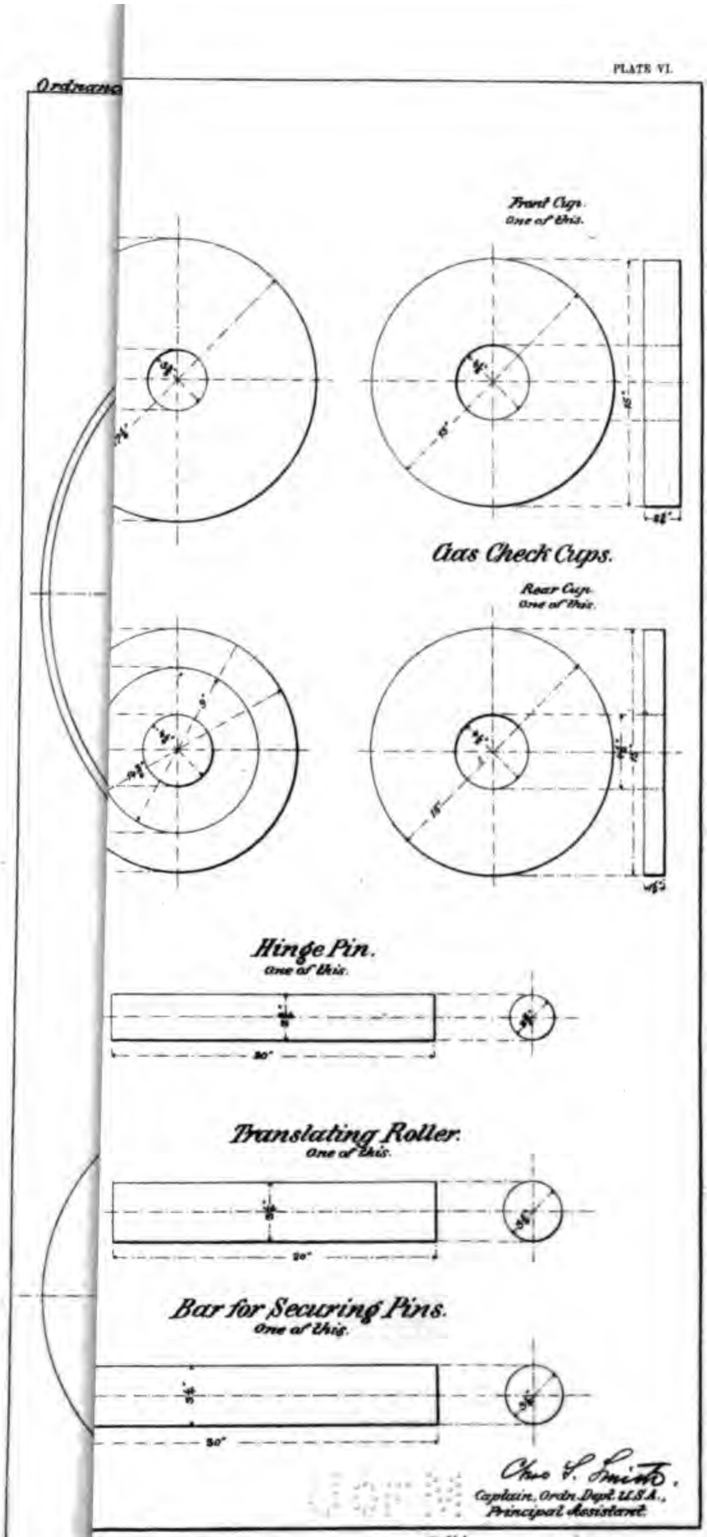


Chas. S. Smith.
Capt. of Ordnance,
Principal Assistant.



Chas. S. Smith,
Captain, Ordn. Dept. U.S.A.,
Principal Assistant.

APPENDIX 21.

ADVERTISEMENTS, SPECIFICATIONS, AND PROPOSALS FOR FORGINGS, CAST-IRON BODIES, AND MANUFACTURE OF 12-INCH BREECH-LOADING RIFLED MORTAR, CAST-IRON, HOOPED WITH STEEL.

(4 plates.)

[Advertisement.]

PROPOSALS FOR 12-INCH MORTAR BODIES.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, November 14, 1888.

Sealed proposals, *in duplicate*, will be received at this office until 1 o'clock p. m., on Saturday, December 15, 1888, at which time they will be publicly opened, for supplying the Ordnance Department, U. S. Army, with twenty-seven cast-iron bodies, more or less, for 12-inch mortars. Blank forms on which proposals must be made and all information required by bidders can be had upon application.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

INSTRUCTIONS TO BIDDERS FOR CAST-IRON BODIES FOR 12-INCH BREECH-LOADING MORTARS.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, November 14, 1888.

The cast-iron bodies for 12-inch mortars, for which proposals are invited under newspaper advertisement of this date, must conform in quality and dimensions to the specifications and drawings to be had at this office.

Bidders will state the price for each body, when the first body will be delivered, the rate at which deliveries will be made after the first delivery, and when deliveries will be completed.

The right is reserved to waive informalities and to reject any and all bids.

Envelopes containing proposals should be marked "Proposals for 12-inch mortar bodies," and be addressed to "The Chief of Ordnance, U. S. Army, Washington, D. C."

Copies of the advertisement, of these instructions to bidders, of the specifications, and of the drawings must accompany and form part of proposals.

The bidder to whom contract is awarded must execute the same in quintuplicate, with good and sufficient sureties for the faithful performance thereof within fifteen days after receiving written notice of acceptance of proposal.

Contract for the manufacture of these mortar bodies will require that the accepted and rough-finished bodies be delivered without charge on board cars or other conveyance where they can be taken up by some convenient shipping line for transportation by the United States if desired; and will stipulate that if the bodies are not delivered at the proposed times there will be imposed on the contractor a penalty of $1 per day on the price of each body for each day of delay in delivery.

Payment for each body will be made on delivery, less 5 per centum, to be retained until the completion of the contract.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

SPECIFICATIONS FOR CAST-IRON BODIES FOR 12-INCH BREECH-LOADING RIFLED MORTARS.

(Two sheets of drawings.)

The cast-iron bodies for 12-inch breech-loading rifled mortars are to be of the rough-finished dimensions shown on accompanying drawing, these dimensions to be subject to such slight modification as the United States may wish to make, not materially affecting the cost of manufacture. All rough-bored and turned surfaces must be straight and true, and without eccentricity.

The castings to be of charcoal pig, and to be made breech down with a straight, cylindrical bore. The exterior, inclusive of the sinking head, to be nearly cylindrical—the exterior diameter at no place being less than at the breech. The weight of the sinking head, over and above that portion of the rough casting required for the mortar body and specimen slices, shall be at least one-fifth of the total weight of the whole casting.

The casting to be cooled from the interior by a current of water and without steaming the metal, the portion of the core barrel through which water circulates extending below the breech initial tension ring, the exterior at the same time being kept hot by a fire built around the flask within the casting pit, all according to the usual Rodman process, regulated in such manner as to secure a gradual and uniform cooling, that shall leave the casting free from irregular or excessive internal strains. In pouring the metal into the mold the flow must be continuous and uniform, and any evolution of gas except along the flutes of the core arbor may be sufficient cause for rejecting the casting.

The tensile strength of the metal must average at each end at least 30,000 pounds per square inch; no specimen to be over 37,000 pounds per square inch; but one specimen from the muzzle end and two from the breech end may be as low as 28,000 pounds per square inch. The long extension specimens will not be considered in making up these averages.

The slices from which test specimens and initial tension rings are to be taken, the positions of which with reference to the body are shown on accompanying drawing, will be cut from the casting and cleaned up on the interior to 12 inches diameter; the initial tension-rings will then be detached. The inside rings must indicate the existence of tangential compression and the outer ring (at breech) the existence of tangential extension in the part of the casting from which they are taken. Median circumferences will be scored on the rings before the work of cutting out is commenced; a comparison of the measurements of these circumferences made before and after the rings are detached must show expansion of the inside rings and contraction of the outer rings. The test specimens required, shown on accompanying drawing, will then be cut out and finished. The rings and specimens are all to be furnished without cost to the United States.

If the contractor possesses a reliable testing machine, and if the results obtained with such testing machine are found to be comparable with those obtained with the United States testing machine at Watertown Arsenal, then the test specimens required shall be tested by the contractor in such manner as shall be prescribed by the United States and in the presence of the inspector, and the inspector shall be furnished with the orginal notes of the several tests, that they may be worked up in his office. If the contractor has no reliable testing machine, then all the specimens shall be tested at Watertown Arsenal. All specimens which are to be tested at Watertown Arsenal shall be sent to that place by the contractor, by express, at his own expense. All specimens shall pass through the senior inspector's hands for inspection and record. Tests made by the contractor shall be without cost to the United States. If tests are made at Watertown Arsenal, then the actual cost of testing and recording specimens shall be charged to the contractor.

The castings must be sound, free from cavities, blow-holes, soft spots, or flaws, and the manufacture must be open to inspection by officers of the Ordnance Department in all its details, and receive the approval of the Department in all its stages.

PROPOSAL FOR TWENTY-SEVEN BODIES FOR 12-INCH B. L. RIFLED MORTARS.

CINCINNATI, OHIO,
December 13, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for twenty-seven cast-iron bodies, rough finished, for 12-inch B. L. rifled mortars, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish twenty-seven cast-iron, rough-finished, B. L. mortar bodies, cast from charcoal iron, and to be machined in strict conformity with specifications attached hereto, for the sum of $2,850 each, viz, $76,950 for the twenty-seven bodies. Delivery of the first body after two months or within four months, our option, from execution of contract, and two bodies per calendar month thereafter, f. o. b. cars, Cincinnati, Ohio, inspection and acceptance of bodies to be made at our works. Specimen test to be made at Watertown Arsenal.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

THE UNIVERSAL RADIAL DRILL COMPANY, [L. S.]
By P. G. MARCH, *Secretary*.

Witnesses:
HOMER HARDY.
J. W. MARCH.

PROPOSAL FOR CAST-IRON BODIES FOR 12-INCH MORTARS.

PROVIDENCE, R. I., *December* 10, 1888.

THE CHIEF OF ORDNANCE, U. S. ARMY,
Wilmington, Del.:

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for twenty-seven cast-iron bodies (more or less) for 12-inch B. L. mortars and the instruction to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to make and deliver on cars or wharf in Providence twenty-seven (more or less) rough-turned and bored mortar bodies for $1,475.

The first body we will deliver in eight weeks after contract is awarded us, and the twenty seventh within one year after.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

BUILDERS IRON FOUNDRY [L. S.].
R. A. ROBERTSON, JR., *Treasurer*.

Witness:
H. J. BURROUGH.

PROPOSAL FOR 12-INCH MORTAR BODIES.

WEST POINT FOUNDRY,
Cold Spring, N. Y., December 14, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for twenty-seven cast-iron mortar bodies (more or less) for 12-inch mortars and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish the said bodies for 12-inch mortars in accordance with drawings, specifications, and instructions to bidders for $2,750 each, provided the amount of bodies which may be required on the contracts shall not be in excess of what we can obtain from the parties who propose to become our bondsmen. The first body will be delivered in ten weeks from receipt of contract, and three per month thereafter until completion, if desired.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

WEST POINT FOUNDRY CO. [L. S.]
By F. W. RHINELANDER, *President*.

Witness:
OSCAR BURKE.

PROPOSALS FOR CAST-IRON BODIES FOR 12-INCH B. L. RIFLED MORTARS.

DECEMBER 11, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for cast-iron bodies for 12-inch B. L. rifled mortars and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, The South Boston Iron Works propose to furnish twenty-seven bodies (more or less) for B. L. rifled mortars in accordance with specifications, drawings, and advertisement hereto attached, and to be made of the same material and under the same treatment as the 12-inch rifled mortars which have been tested and are now at Sandy Hook, and to deliver the first mortar body in six weeks after the contract is signed, and the balance at the rate of one in every ten days thereafter, for the sum of $2,750 each.

The South Boston Iron Works make this proposal with a full knowledge of the kind, quantity, and quality of the articles required and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

THE SOUTH BOSTON IRON WORKS [L. S.]
By WM. P. HUNT, *President.*

Witness:
W. J. MUTZT.

[Advertisement.]

PROPOSALS FOR 12-INCH MORTAR FORGINGS.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, November 14, 1888.

Sealed proposals, in duplicate, will be received at this office until 1 o'clock p. m., on Saturday, December 15, 1888, at which time they will be publicly opened, for supplying the Ordnance Department, U. S. Army, with twenty-seven sets, more or less, of steel forgings, of American manufacture, for trunnion hoop, hoops, and breech mechanism for 12-inch mortars. Blank forms on which proposals must be made and all information required by bidders can be had upon application.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

INSTRUCTIONS TO BIDDERS FOR FORGINGS FOR 12-INCH BREECH-LOADING MORTARS.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, November 14, 1888.

The forgings for 12-inch mortars, for which proposals are invited under newspaper advertisement of this date, must conform in quality and dimensions to the specifications and drawings to be had at this office.

Bidders will state the price per set for the forgings, when the first set will be delivered, the rate at which deliveries will be made after the first delivery, and when deliveries will be completed.

The right is reserved to waive informalities and to reject any or all bids.

Envelopes containing proposals should be marked "Proposals for 12-inch mortar forgings," and be addressed to "The Chief of Ordnance, U. S. Army, Washington, D. C."

Copies of the advertisement, of these instructions to bidders, of the specifications, and of the drawings must accompany and form part of proposals.

The bidder to whom contract is awarded must execute the same in quintuplicate, with good and sufficient sureties for the faithful performance thereof, within fifteen days after receiving written notice of acceptance of proposal.

Contract for the manufacture of these forgings will stipulate that if the sets of forgings are not delivered at the proposed times there will be imposed on the contractor a penalty of $1 per day on the price of each set of forgings for each day of delay in delivery.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

PROPOSAL FOR 12-INCH MORTAR FORGINGS.

PHILADELPHIA, PA., *December* 14, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for twenty-seven sets, more or less, of steel forgings, of American manufacture, for trunnion-hoops, hoops, and breech mechanism for 12-inch mortars, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish the twenty-seven sets, more or less, of steel forgings, of American manufacture, for trunnion-hoops, hoops, and breech mechanism for 12-inch mortars for $2,770 per set. The first set to be delivered in one hundred and twenty-days after signing contract, the next six sets at the rate of one set every forty days, and the balance, twenty sets, at the rate of one set every twenty days, completing deliveries in seven hundred and sixty days after signing contract.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

MIDVALE STEELE CO., [L. S.]
By CHARLES HARRAH, *President.*

Attest:
ELWOOD W. KIMBER, *Secretary.*

PROPOSAL FOR 12-INCH MORTAR FORGINGS.

SOUTH BETHLEHEM, PA., *December* 8, 1888.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

SIR: In accordance with your advertisement of November 14, 1888, inviting proposals for twenty-seven sets, more or less, of steel forgings, of American manufacture, for trunnion-hoop, hoops, and breech mechanism for 12-inch mortars, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to furnish twenty-seven sets of steel forgings of American manufacture for trunnion-hoop, hoops, and breech mechanism for 12-inch mortars at $5,496.67 per set, f. o. b. cars, at works of the Bethlehem Iron Company—deliveries to be made as follows from date of contract: First set within ten months; second set within eleven months; third set within one year; thereafter at the rate of two sets per month, completing delivery within two years—and make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

THE BETHLEHEM IRON CO., [L. S.]
Per ROBT. H. SAYRE, *General Manager.*

Attest:
ABRAHAM S. SCHROPP, *Secretary.*

[Advertisement.]

PROPOSALS FOR 12-INCH BREECH-LOADING RIFLED MORTARS.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, June 22, 1889.

Sealed proposals, in duplicate, will be received at this office until 3 o'clock p. m., on Monday, July 22, 1889, at which time they will be publicly opened, for finishing and assembling twenty-nine 12-inch breech-loading rifled mortars, more or less, the principal parts being supplied by the United States. Blank forms on which proposals must be made and all information required by bidders can be had upon application.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

INSTRUCTIONS TO BIDDERS FOR FINISHING AND ASSEMBLING 12-INCH BREECH-LOADING MORTARS.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, June 22, 1889.

This finishing and assembling of 12-inch breech-loading rifled mortars of cast-iron hooped with steel, for which proposals are invited under newspaper advertisement of this date, must be done in accordance with the specifications and drawings, to be had at this office.

Bidders will state the price for each finished mortar; also the time in which the first mortar will be completed after the receipt of the parts for it to be supplied by the United States, the rate of subsequent deliveries, based upon the time of the receipt of the parts for each to be supplied by the United States, and the time in which all the mortars will be completed after the delivery of all the material therefor to be supplied by the United States.

Bidders are informed that, depending upon the fulfillment of existing contracts for the material, the rates of delivery to the contractor for this work of the parts to be furnished by the United States will be approximately as follows: For the cast-iron bodies, two or more when contract is made, and thereafter not less than two per month, or the whole number within one year; for complete sets of the steel forgings, two or more when contract is made and seven sets in all within seven months at a rate after the first delivery of one set every forty days, and the remaining sets all within fourteen months thereafter at the rate of about one set every twenty days.

Proposals must be made upon the form furnished by this office, and copies of the advertisement, of these instructions to bidders, of the specifications, and of the drawings, must accompany and form part thereof, and the bidders' guaranty must be filled out as indicated thereon.

The right is reserved to waive informalities and to reject any or all bids.

The bidder to whom contract is awarded must execute the same in quintuplicate, with good and sufficient sureties for the faithful performance thereof, within fifteen days after receiving written notice of acceptance of proposal.

Contract for these mortars will stipulate that if the finished mortars are not delivered at the proposed times there will be imposed on the contractor a penalty of $1 per day on the price of each finished mortar for each day of delay in its delivery.

Partial payment for each mortar finished, except the shot-chamber, the rifling and lapping, prior to the determination of the form of chamber and the rifling, as provided in the specifications, will be made, on acceptance of the work done, to the amount of 88 per cent. of the cost of a finished mortar. Said payment, it will be understood and agreed, shall cover the care and storage of such mortars by the contractor, for a reasonable period, pending the cessation of work thereon. And an additional payment of 7 per cent. will be made on the aforesaid mortars when such shall have been completely finished and accepted.

Payment for each finished mortar will be made on delivery and acceptance, less 5 per cent., to be retained until the completion of the contract.

Envelopes containing proposals should be marked "Proposals for 12-inch breech-loading rifled mortars," and be addressed to "The Chief of Ordnance, U. S. Army, Washington, D. C."

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

SPECIFICATIONS FOR THE MANUFACTURE OF 12-INCH BREECH-LOADING RIFLED MORTARS.

[Seven sheets of drawings.*]

Twelve-inch breech-loading rifled mortars are to be manufactured under the following specifications:

All the parts will be accurately finished, fitted, and assembled, and the mortars completed in all respects as shown on the accompanying drawings.

Material.—All of the material required for the work will be furnished by the contractor. The cast-iron bodies and the steel forging for hoops and principal parts of breech mechanism must conform in manufacture and qualities to the specifications prescribed by the Ordnance Department, which are hereto attached. All the additional minor parts of breech mechanism, for which no specifications are prescribed, must be of the best quality for the use intended. The bronze castings shall be an alloy containing 88 per cent. of copper, 2 per cent. of zinc, and 10 per cent. of tin, except the console, which shall be an alloy containing 55 per cent. copper, 44.5 per cent. zinc, and 0.5 per cent. tin. All alloy castings to be made of new metals.

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* The same as the nine drawings accompanying specifications for "finishing and assembling," excepting those marked "B" and "C."

Work of assembling.—In the sequence of the operations of assembling each mortar it is prescribed that the trunnion-hoop shall be completely finished before shrinkage, and the remaining hoops turned on the exterior to leave a surplus of about one-eighth of an inch on the finished diameters prescribed. Preparatory to shrinkage also, the bore, the cylindrical portion of chamber, and the breech recess of the cast-iron body shall be smooth bored to about one-tenth of an inch less than the finished diameters prescribed, to admit of making accurate star-gauge measurements of the bore, the cylinder of chamber, and the breech recess in the several stages of the work. The seat for the toothed arc in hoop A_7 must be cut after the hoops are assembled and the exterior of the mortar must be turned to the finished diameters prescribed before any part of the interior is fine-bored or finished.

In fine-boring and facing the hoops for shrinkage the allowed variations for prescribed diameters, eccentricity, conicalness, and parallelism of ends will be 0.003 of an inch. The allowed variation for length of hoop will be ± 0.01 of an inch.

The hoops will be applied under a definite shrinkage to be determined by the United States, the following variations being allowed, viz:

Between cast-iron body and inner row of hoops + 0.003 of an inch and — 0.000.

Between the two rows of hoops — 0.003 of an inch and + 0.000.

For the operation of hooping the contractor must supply a suitable press to keep the joints between hoops accurately closed while the applied hoop is cooling and a circular sprinkling arrangement to cool the hoop uniformly by sections, beginning at the end first put on. The heating of the hoops for shrinkage must be so conducted as to insure a uniform temperature. The clearance for the assemblage may vary between 0.035 and 0.05 of a inch, not to exceed the latter, which corresponds to a maximum elevation of temperature of about 500° Fahrenheit above the temperature of the shops. During the hooping a current of cold water must be circulated through the bore.

In finishing the bore and chamber, following the exterior finish, two cuts at least must be taken—the last being made slight enough to produce the best quality of finish. The shot-chamber must be finished prior to the rifling.

After the fine boring and rifling the bore and chambers will be finished by lapping. The allowed variation in diameters of finished chambers and bore within lands, also diameters to bottom of grooves, will be +0.003 of an inch and — 0.000; but in finishing the parts of the interior which the chamber-gauge, shown on the sheet marked F, is intended to fit, the work shall be made (within the limits prescribed) as nearly as possible an exact counterpart of the gauge. This chamber-gauge will be furnished by the United States. The allowed variation in width of lands or grooves will be $\pm$ 0.005 of an inch.

A second gauge, for gas-check seat, will be furnished by the United States the dimensions of the bevel at the rear of chamber which constitutes the seat for the gas-check must be finished to fit this gauge accurately.

All dimensions to be subject to such slight changes, not materially affecting the cost of the work, as the United States may wish to make as the work progresses, and any changes materially affecting the cost of the work to be paid for at a fair price, to be determined by the contracting parties.

The finished mortars will be delivered to the United States at the works of the contractor.

The work must be open to inspection by officers of the Ordnance Department in all its details and receive the approval of the department at all stages of its progress.

PROPOSAL FOR FINISHING AND ASSEMBLING TWENTY-NINE BREECH-LOADING RIFLED MORTARS, MORE OR LESS.

PROVIDENCE, R. I., *July* 18, 1889.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In accordance with your advertisement of June 22, 1889, inviting proposals for finishing and assembling twenty-nine breech loading rifled mortars, more or less, the principal parts therefor to be supplied by the United States, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, we propose to complete the first mortar within six months after the receipt of the parts for it to be supplied by the United States; and thereafter to complete the remaining twenty-eight mortars at the rate of about one every four weeks,

provided the parts for each, to be supplied by the United States, shall have been received at least six month previous to the completion of each; and to complete all the mortars within two years and eight months of date of contract, for the sum of $3,725 for each finished mortar.

We make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

BUILDERS IRON FOUNDRY. [L. S.]
R. A. ROBERTSON, JR., *Treasurer.*

Witnesses:
H. J. BURROUGH.
R. E. LYMAN.

PROPOSAL FOR FINISHING AND ASSEMBLING 12-INCH BREECH LOADING RIFLED MORTARS.

BOSTON, *July* 18, 1889.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

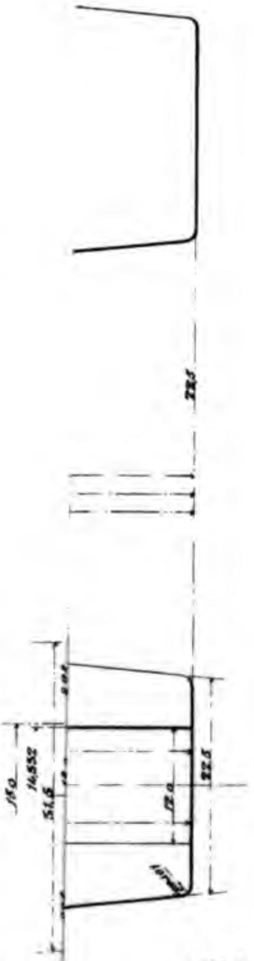
SIR: In accordance with your advertisement of June 22, 1889, inviting proposals for finishing and assembling twenty-nine 12-inch breech-loading rifled mortars, the principal parts therefor to be supplied by the United States, and the instructions to bidders issued thereunder, copies of which are hereto attached and made a part of this proposal, the South Boston Iron Works propose to furnish and assemble the said twenty-nine 12-inch mortars and complete the first mortar within six months after the receipt of the parts for it to be supplied by the United States, and thereafter to complete one mortar every two weeks after the first mortar has been finished, provided the parts for each, to be supplied by the United States, shall have been received at least six months previously; and to complete all the mortars within six months after the receipt of all the material therefor to be supplied by the United States, for the sum of $4,500 for each finished mortar.

The South Boston Iron Works make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and the requirements of the specifications and drawings hereto attached, and if it is accepted will, after receiving written notice of such acceptance, enter into contract within the time designated in the instructions to bidders, with good and sufficient sureties for the faithful performance thereof.

SOUTH BOSTON IRON WORKS, [L. S.]
By WM. P. HUNT, *President.*

WITNESSES:
EDWARD G. POOLE.
F. L. CROSBY.

A.



Approved:

Chas S. Smith

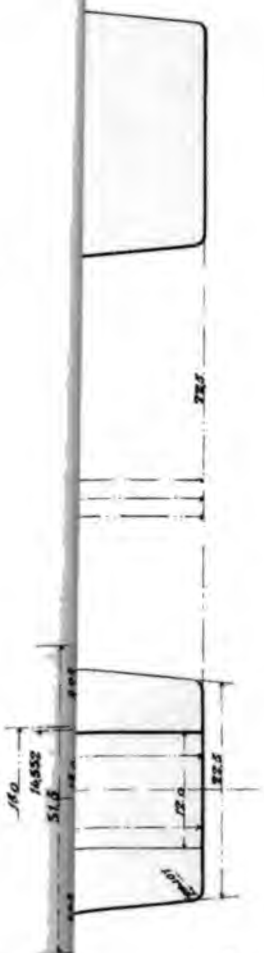
Brigadier General
Chief of Ordnance,

Captain of Ordnance,
Principal Assistant.

Ordnance Office,

PLATE I.

A.



Approved:

Brigadier General
Chief of Ordnance, U

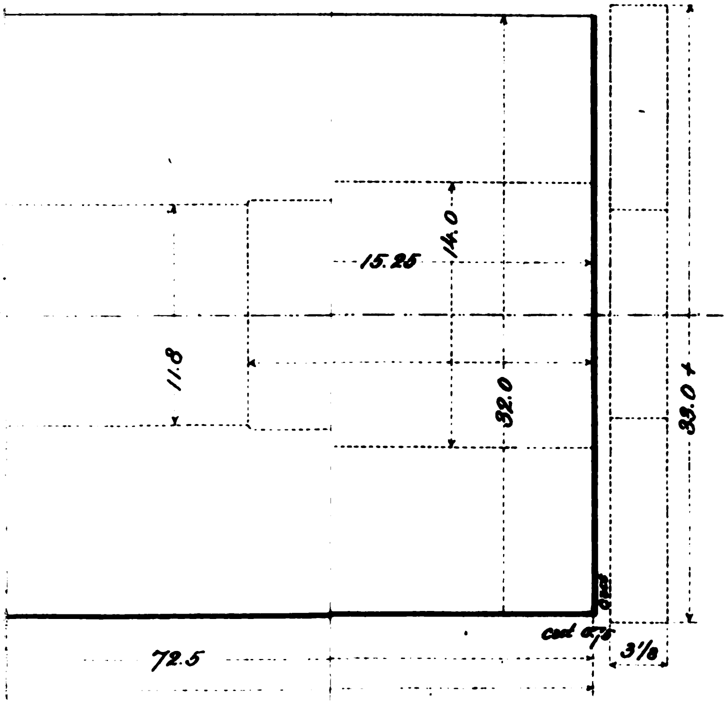
Chas S. Smith

Captain of Ordnance,
Principal Assistant.

PLATE II.

B.

FLED MORTAR



Chas. S. Smith

Captain Ordnance Dept.,
Principal Assistant.

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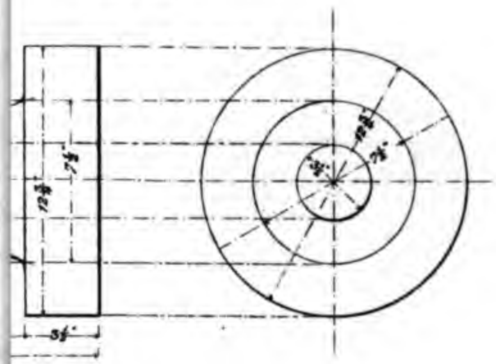
Appendix 21 1889.

C.

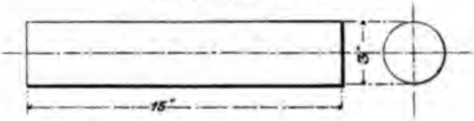
Spindle.

One of this.



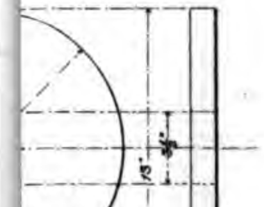
Translating Roller.

One of this.



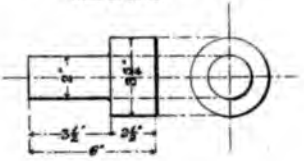
aps.

this.



Pinion 1.

Smooth Forging.
One of this.



Chas. S. Smith.
Captain, Ordn. Dept. U.S.A.
Principal Assistant.

APPENDIX 22.

BUILDINGS, AND OFFICERS' QUARTERS FOR ARMY GUN-FACTORY, WATERVLIET ARSENAL, WEST TROY, N. Y.

(4 plates.)

1.—SPECIFICATIONS FOR THE ERECTION AND COMPLETION OF A GUN-FACTORY BUILDING, INCLUSIVE OF THE BRIDGE, OR RUN-WAYS FOR A TRAVELING-CRANE; TO BE SITUATED AT THE WATERVLIET ARSENAL, WEST TROY, N. Y., AT A PLACE MARKED A ON THE ACCOMPANYING MAP, SHEET NO. 1, AND ACCORDING TO THE ACCOMPANYING PLANS AND DRAWINGS.

CONDITIONS.

The drawings and specifications are intended to be alike in every respect; but any work shown on the drawings and not particularly described in the specifications, and any work evidently necessary to the completion of the building as specified or shown, is to be done by the contractor, without extra charge, the same as if it were shown or specified.

The contractor is to comply with the State or other laws, and is to be liable for all penalties and all damages to life and limb that may occur owing to his negligence, or that of his employés, during the erection of the building. No claim for extra work shall be made unless before the performance of such extra work the Chief of Ordnance shall have first authorized, in writing, such extra work; nor unless, before the performance of such extra work, the price to be paid therefor shall likewise first have been agreed upon in a manner as required by law, between the Government and the contractor, and done in obedience to a written order from the commanding officer, given before the performance of such extra work. An exception will be made from this rule only in the case of foundation masonry, the amount of which may be increased according to the decision of the commanding officer. The bidder will give for this purpose, in addition to his bid for the whole work, the price per cubic yard for which he will furnish such additional stone or brick masonry.

All necessary detail drawings will be furnished, and any work not in conformity with such drawings, or differing from the requirements of the drawings or specifications, or not otherwise approved by the commanding officer, will be rejected, and must be removed, remade, and replaced; and all work or material injured or destroyed thereby must be made good at the contractor's expense. The Government reserves the right to annul and cancel the contract in case the contractor neglects or refuses to remove work rejected, and to replace the same, within three days after having been notified, in strict conformity with the drawings and specifications, and according to the instructions of the commanding officer; and in case the contract is so annulled, all materials furnished and the work done in accordance with the drawings or specifications, at the time the contract is rescinded, is to be paid for at the schedule prices on which the contract price is based, and no claim will be allowed for any profit on work not completed at the time the contract is canceled. The Government reserves the right to employ other parties to remove, replace, or complete the work, holding the contractor for any difference in cost between the actual cost and the unpaid balance of the contract, also for the fixed fines provided in the contract for failure to complete the work within the time specified.

A schedule in detail of the prices on which the contract is based is to be furnished to the Government on signing the contract, which schedule shall be the basis for all payments on account of the contract.

Payments will be made, at the request of the contractor, not oftener than once a month, based on an estimate made by the commanding officer of the amount of work done and of the value thereof, according to the terms of the contract. The first such estimate shall be of the amount or quantity and value of the work done since the contractor commenced the performance of the contract on his part. And every subsequent estimate (except the final one) shall be of the amount or quantity and value of work done since the last preceding estimate was made.

The Government will pay the contractor 90 per cent. of such estimated value upon each such estimate being made.

On the expiration of thirty days after the completion of the contract and the acceptance of the whole work, the Government will pay to the contractor the amount remaining after deducting from the contract price the amount or value of all such sums as shall theretofore have been paid to the contractor under any of the provisions of the contract; also all such sums as shall have been reserved or retained, except as to slating and tinning work, for which such retained sums will not be paid before the expiration of one year after the completion of such work, providing it has given satisfactory proof of its good condition during and up to that time.

All payments made on work during its progress, on account of the contract or extra work, shall in no case be construed as an acceptance of the work executed; but the contractor shall be liable to all the conditions of the contract until the whole work is finished and completed.

The contractor must have some competent person on the work to receive instructions, and see when his particular work is required. Subcontractors will not be recognized.

The Government reserves the right to make any alteration in the plans, forms, construction, detail, or execution, described by the drawings or specifications, without invalidating or rendering void the contract; and in case of any difference in expense, an addition to or abatement from the said contract amount shall be made in the ratio or proportion such work may bear to the whole contract work agreed to be performed; and the same to be determined as before mentioned.

All work will be under the supervision of the commanding officer and such inspectors as he may designate.

Contractors will be notified in writing of any changes in said positions.

The commanding officer will give, on demand, such interpretations, either verbally or by writing or drawing, as in his judgment the nature of the work may require, having particular care that any and all work done, and material used for the work, be such as hereinafter described. He shall also determine the amount of damages which may occur from any cause, and decide upon the fitness of all material used and work done.

It is not incumbent upon him to notify the contractor to attend to and have in readiness his own work, and the requisite materials, at such times as the progress of the building may require them. If the contractor does not attend to his part of the work, and have his portion of the materials and work in readiness as it may be wanted to work into the building, he will be held accountable for all delays and damages in consequence of any such neglect.

The opinion, report, and decision on all matters of the commanding officer will be binding and conclusive.

A railroad track, connecting with the D. & H. Company's track, will be laid to the building site by the Ordnance Department, which will enable the contractor to transport all building material to the site per rail.

Materials and workmanship.

All materials of every kind and description must be of the very best quality, and all work necessary to the completion of the building, as shown in drawings, and as directed by these specifications, is to be executed in the most thorough, substantial, neat, and workmanlike manner, to the entire satisfaction of the commanding officer, to whom every facility is to be given by the contractor for inspecting the work as it progresses.

The contractor is to furnish all necessary materials and labor, and is to provide all tools, derricks, hoists, scaffolding, planks, runs, horses, and all mechanical appliances for properly prosecuting the work.

All water necessary for building purposes may be taken from the hydrants, but the contractor has to make satisfactory arrangements to avoid wasting water by his employés at any time.

Dimensions figured on the drawings are to be followed in all cases in preference to scale-measures, and the wording of specifications takes precedence over both.

Where work is not sufficiently and clearly specified, or where the work is not explained by the drawings, accompanied by a detailed description of the sizes of the various parts and the method of their union, the contractor shall, in all cases, before the execution of the work, submit to the commanding officer for his indorsement and detailed specification for the same. He shall be at liberty to alter and amend such specifications if, in his opinion, the work as described is not of materials, proportions, or workmanship best adapted for the purpose.

GENERAL DESCRIPTION.

The location of the new building is shown in sheet No. 1 of the accompanying drawings, as are also its relative distances from adjoining buildings.

It comprises mainly the following parts:

The *central section* and the *north wing*.

The *central section* comprises: Nine bays of the main aisle; the east extension; the west extension; and the boiler-house.

The *north wing* comprises: Twenty-two bays of the main aisle; the east aisle; and the west aisle.

The total length of the building between wall-lines is 566 feet 2 inches—the central section being 166 feet 2 inches, and the north wing 400 feet long.

The main aisle, 75 feet wide in the clear, forms the principal structure, and extends through the entire length of the building. Its height to the top of walls at eaves is 50 feet, and to the ridge 75 feet, above the floor-line. The floor-line is 4 feet above the floor-line of the present gun-shop.

The east and west aisles form extensions of the principal structure, on both sides of it, for the entire length of the north wing, or 400 feet. These aisles are 22 feet wide between walls, and 18 feet 6 inches high from the floor-line to the under-line of the roof structure, and 34 feet 8 inches to the highest point of the roof. Each one of these aisles communicates with the main aisle by twenty-two large arched openings 12 feet wide by 30 feet high. The east aisle has four, the west aisle three, outside doors.

The east extension of the central section is 52 feet 8 inches long and 15 feet wide in the clear. It has two stories, as shown on plans, and communicates with the main aisle by three arched openings 12 feet wide by 30 feet high. It has two outside doors, north and south. The two middle pilasters of east walls contain flues, divided into two in each pilaster, and extending from the floor-line to the coping, of dimensions shown on drawings.

The west extension is of the same length as the central section, and is subdivided by brick walls into

The tool-room, 45 feet by 22 feet;
The engine-room, 71 feet by 22 feet;
The office, 10 feet 5 inches by 22 feet;
The railroad passage, 13 feet 6 inches by 22 feet; and
The instrument room, 18 feet 9 inches by 22 feet.

Its height is the same as that of the east and west aisles. Built on to the west is the chimney and the boiler-house.

The boiler-house is 71 feet wide by 48 feet 4 inches deep. Height of walls and roof same as that of west extension.

The chimney is 125 feet high from floor-line to top of cast-iron cap. The exterior is square to ridge of boiler-house roof, thence octagonal. The interior shaft is circular, lined with fire-brick to a height shown on drawings. The interior diameter is 6 feet. It has four flue-connections, two oblong and two circular, and is topped out as shown in drawing.

The shrinkage-pit is located in the middle of the central section. It is 40 feet long by 20 feet wide, and has four levels —two at 20 feet, one at 35 feet, and one at 50 feet below the floor-line. It is topped out with a stone wall.

The central section is traversed by two *railroad tracks*, the main track and the north siding.

The level of top of rails is 3 feet below the floor-line. A stone gutter between and beneath rails of main track.

There are sixteen exterior doors in the whole building, viz: Two railroad doors in east wall of central section; one railroad door in outer wall of west extension; two doors in north and south walls of east extension; one door in west wall of boiler-house; one door in south wall of west extension; two doors in north and south walls of main aisle; four doors in east aisle, and three doors in west aisle. All exterior doors and windows are shown in elevations of buildings. All interior doors and windows are shown in plans and sections. The foundations of all exterior walls are built of rubble masonry, laid on concrete. The foundation of the chimney consists of large stone blocks bedded on concrete. All other walls and chimney are built of bricks. All interior partition walls are topped out to roof.

The roof construction of main aisle, east extension, boiler-house, and engine-room is of iron, with wooden purlins and covering. All other roof constructions are combined of iron and wood. All roofs are covered with slate. A ventilator and skylights are in roof of central section, and a sky-light in roof of engine-room.

The main aisle contains iron bridges or runways for traveling cranes, extending through its entire length.

The arrangement of the building, and all sizes, dimensions, and details are fully shown on drawings. If any discrepancy is discovered in the drawings, or between them and the specifications, the question is to be referred to the commanding officer for settlement.

Excavations and grading.

The leveling of site, as also all excavations for foundation trenches, pits, and shrinkage-pit are already contracted for, and all such excavations for walls and piers will be completed on or before the *1st of May*, 1889. After the walls and piers are above ground the trenches, etc., must be refilled and solidly rammed around walls and piers by the contractor for the mason-work. He is also to fill and grade the grounds around outside walls for a distance of 6 feet from wall-line on the east side, and of 15 feet on all other sides of the building. All ground-lines around the building must slope away from walls, as shown, and ground must be tightly rammed. The highest points of ground outside of walls will be 1 foot below the floor-line, the lowest point not lower than 1 foot below highest point.

Concrete.

The foundations of all walls, piers, and of the chimney will be laid on a bed of concrete at the bottom of the excavations. The depth and all other dimensions of concrete beds are shown in drawings. The concrete shall be formed of sound broken stone, not exceeding 2 inches at their greatest diameter, and of a quality approved by the commanding officer. All stone in any way larger is to be thrown out. The sand to be used must be of a coarse grain, clean and sharp, and free from loam.

The *cement* must be equal in quality to the best Rosendale cement, and made by manufacturers of established reputation; it must be fresh and very fine ground, and in well made and lined casks. The tensile strength of a specimen, twenty-four hours after molding, air-dry, must not be less than 80 pounds per square inch of section. To insure its good quality, all the cement furnished by the contractor will be subject to inspection and rigorous tests, and if found of improper quality will be branded, and must be immediately removed from the site. The contractor shall, at all times, keep in store, at some convenient point in the vicinity of the work, a sufficient quantity of cement to allow ample time for the tests to be made without delay to the work of construction. The commanding officer shall be notified at once of each delivery of cement. It shall be stored in a tight building, and each cask must be raised several inches above the ground by blocking, or otherwise.

The materials for concrete to be cleaned from dirt and dust before being used; to be mixed *dry* in proper boxes in the following proportion: One part by measure of cement to two parts of sand and five parts of broken stone.

The sand will be put into the box first, and spread out; the cement will be spread over the sand then, and both will be turned over three times to assure a uniform mixture. The stone, having been well wetted, is next added, and all ingredients are turned over twice with shovels, adding a moderate quantity of water to produce a mixture of proper consistency.

The mixing is to be done near the place of laying, the concrete to be laid, immediately after mixing, into wetted ground, and to be thoroughly compacted with heavy tampers till the water flushes to the surface. The concrete shall be allowed to set for about twenty-four hours before any work shall be laid upon it; the time of setting can be reduced only by permission of the commanding officer. No walking over or working upon it shall be allowed while it is setting.

Contractor to furnish the concrete necessary for the construction of the railroad bed within the building, and for a distance of 25 feet outside of it, as shown in cross-section on foundation plan.

The floor of the east extension will be made of concrete, 6 inches thick laid on well-rammed ground, evenly up to within 1 inch of the floor-line. The top of such concrete is to be flushed off level with a coat of cement 1 inch thick. Should the ground be lower than required for the concrete, the contractor will fill up with shale from the excavations, ram well, and grout with a mixture of one cement to two sand to make the ground compact. The concrete floor is to finish off on inside of wall of main aisle. The floor of the three middle bays of the central section, around shrinkage-pit, is to be prepared in the same manner as the floor of the east extension, but instead of a coat of cement it will receive a coat 1 inch thick of best Swiss (Neufchatel) asphalt. Care must be taken to give this asphalt floor a slight pitch on all sides toward the shrinkage-pit. This asphalt floor and its concrete bed can not be made before the shrinkage-pit is entirely excavated and lined and the retaining walls have been built at its top.

Cut stone.

All cut stone required for the new building is shown on sheet No. 8 of the accompanying drawings, and comprises the following:

1. The water-table, the door-sills, window-sills, coping-stones, belt-courses, and string-stones of sizes and shapes as shown on drawings.

Bed and build of this stone to be trued and smoothed with a good point finish; all exposed surfaces (the top of window-sills and door-sills entirely) to have a neat pean-hammer cut, cross-cut, four-cut, or axed finish.

The water-table to be furnished in lengths not less than figured in drawings, but contractor may double lengths at his option.

The coping-stones to be furnished in convenient lengths, but nothing shorter than 6 feet.

All window-sills exceeding 6 feet in length must be made in two pieces. A groove, for the reception of a wrought-iron clamp, will be cut in the joint faces of the two stones forming one sill, with sinkings in the top surfaces for letting in the turned-down extremities of the clamps, as shown in detail. The clamps will be furnished by the Ordnance Department, the contractor to put them in place, and to lead them into the stone. The clamps must not come up to top of sill, and the sinkings must be finished off with neat cement, level with top of sills, to conceal the clamps and make joint water-tight.

The door-sills are to be furnished in one single piece, and are to be provided with mortises for the door-jambs.

All joints of window-sills and water-table must be very close.

Belt courses and stones, in level with lower window-sills, are: Along east front of central section, along north front of main aisle, and in all corner pilasters of the building. Two courses are in middle pilasters and one course in each corner pilaster of east extension. All as shown in drawings.

The caps of middle pilasters of east extension will be of cast-iron.

Exposed faces of coping-stones to have a finish as described above; bed and anterior edge rough-dressed, as usual. The coping in front of gutters to have a recess (raglet) on top throughout its length, and not less than 1 inch deep, to receive the apron of the tin gutter at the back of the cornice; also holes to be cut in every 6 feet for the reception of an iron brace; all as shown on detail drawing of gutter. The described cutting on top of coping-stones to be done in place, especially as the recesses for the iron braces will have to correspond with the construction of the snow-fender. There must be lead plugs in all joints of coping-stones. The above gutter aprons and iron braces will be leaded in by the contractor for the tin-work and snow-guards.

2. Sixty-four cap-stones of piers for columns of crane-bridge—57 small ones and 7 large ones—of sizes shown in detail drawings. These stones to be square, and to have parallel and true bearings top and bottom (point-finish). The top must be smoothly finished, the sides to have rock faces. Four 2-inch holes to be cut in each stone from top to bottom, to figures given in drawing.

3. Eighty stone blocks for the reception of the iron shoes of roof-trusses. Top, bottom, and one small side square, parallel, and true, and dressed with a pean-hammer, cross-cut or four-cut; all other faces to be rough-dressed. Such recesses or holes as are shown in drawing to be cut in these stone blocks.

4. Forty-six hinge-blocks of sizes and shapes shown in drawings, and to be neatly dressed all over. Contractor to cut recesses for hinge-eyes into blocks (two of these hinge-stones are string-stones in west wall of boiler-house). Contractor to apply for a pattern of hinge-eyes and all other anchors, straps, or clamps which, in compliance with the foregoing, are to be recessed into stone-work.

All cut stone described in items 1 to 4, inclusive, is to be of first-class granite, North River blue stone, or of other hard and suitable stone of approved quality, free from all defects, and uniform in color. The bidder to submit with his bid a sample or samples of stone showing texture and the different kinds of finish required, and on which his bid is based,

The stones shall be cut to exact dimensions, and all angles and arrises shall be true, well-defined, and sharp. All beds, builds, and joints shall be dressed for the full depth of the stone, all joints to be very close.

The contractor to do all cutting in place which is necessary for the completion of any work on the building.

All stone to lie on its natural bed.

Besides the above cut-stone work, there will be required two tiers of large granite blocks for the foundation of the chimney. These stones must be about 16 inches thick and of sizes and dimensions approximately as shown on the drawing. The bottom and upper course must break joints everywhere. Stones to have broken faces all over, flat top and bottom, and edges as square as possible. No stone should have less than 12 superficial feet.

All stone to lie on its natural bed.

All stone to be finished and delivered in time for the mason.

Stone masonry.

The foundations of all exterior walls of the building below the water-table are to be built of rubble masonry.

The stone for this rubble masonry will be furnished by the Ordnance Department near the site of the building.

The foundation walls are to be built upon a bed of concrete, as described heretofore. All stone resting direct on the concrete must be bedded in pure domestic cement of approved quality. The rest of the rubble masonry to be laid in hydraulic-cement mortar. All stone to be laid on its natural bed. All beds and joints must be full of mortar, and no grouting or filling of joints will be allowed after the stones are in place. The work must be thoroughly bonded. For the outside face of walls, at least for a depth of 12 inches below the water-table, square stones should be selected, with exposed faces smooth and clean.

Top and sides of the rubble masonry to be finished perfectly straight, and top to form a uniform horizontal, and level bearing throughout for the water-table and the brick-work. Joints to be full of mortar, close and well flushed up. All face-joints above ground, and also all joints in water-table and in window-sills, to be pointed with pure cement, applied before its setting.

All stones to be wetted, and all walls under ground to be cemented on outside.

Mortar for the rubble masonry shall be prepared from cement of the same quality as specified for concrete—one part, by measure, of cement to two parts of clean, sharp, screened sand.

These ingredients shall be thoroughly mixed *dry*. A moderate quantity of water is afterward added to produce a paste of proper consistency; the whole to be thoroughly mixed with hoes. In measuring cement it shall be packed as received from the manufacturer. The mortar shall be freshly mixed in proper boxes for the work in hand, and no mortar must be used that had become hard or set.

All rubble masonry is to be built to the dimensions shown on the drawings. It includes the stone sills of railroad doors, between and on either side of rails; the retaining walls of the railroad passages within the building, and for a distance of 25 feet outside from the face of walls of the building; the stone gutter in the center of the southern railroad passage, and the wall surrounding the top of the shrinkage-pit. The stone for all this work to be furnished by the Ordnance Department. The top course of the retaining walls and of the wall on top of the shrinkage pit to be built of as large stones as can be obtained. All exposed surfaces to be straight and smooth. The stones forming these top courses to be clamped together with wrought-iron clamps made of 1¼ by ⅝ inch iron, with 3-inch legs 6 inches from each end, to be leaded into stone. The contractor to do the cutting and leading, the Ordnance Department to furnish the iron anchors.

It may be necessary to excavate the trenches for foundation walls on some points to a greater depth than shown on drawings. In all such cases the contractor will build the increased amount of masonry. Therefore, in addition to his bid for the whole work, he will give the price per cubic yard for which he will furnish any masonry in excess of that shown on the plans.

All foundation walls to rise uniformly, and no brick-work to be started on the rubble masonry before the latter is completed throughout, and levels taken by the Department have shown the level of walls to be uniform.

The foundation of the chimney is to form two courses of dimension stones, shown on drawings. All stones to have good beds and builds, to be laid edge to edge, and to break joints everywhere. They must be laid in fresh domestic cement of approved quality, the cement to fill completely all crevices in beds and to be well tamped in and into joints. The top course shall present an even and level surface upon which to start the brick-work.

The upper or cap stone of each pier for columns of traveling-crane must be solidly bedded, with top side dressed square and level to receive columns. The holes for foundation-bolts to be in perfect line with axis of building.

Hinge-blocks, recessed for wrought-iron hinge-eyes, of dimensions shown in drawings, to be built into walls where shown, viz, eight for each of the three railroad doors and the two main entrances in north and south walls, and six for the outside door of the boiler-house.

The hinge-eyes must be properly set and leaded into stone.

All stone blocks for roof-trusses to be properly set and leveled, and solidly anchored to walls. All walls and pilasters to be capped with stone of sizes and dimensions shown on drawings, laid with close joints and pointed with pure cement. Coping-stones in front of gutters to have a recess on top for the reception of the apron of the gutter, and recesses for anchors, all as described under the heading "Cut stone."

All cut-stone work to be well bedded in pure domestic cement of approved quality, and to be anchored to walls wherever shown on drawings.

All wrought-iron anchors, straps, clamps, and hinge eyes will be furnished by the Department, the contractor to put them in place and secure them as shown or specified.

All channels or recesses in stone, for clamps, must be deep enough to conceal the clamps, and are to be filled on top with cement to protect the latter from oxydation.

The Department will do all necessary surveying, give all lines and grades, and will furnish and locate all necessary stakes and bench-marks for building-lines. All stakes and marks to be carefully preserved by the contractor, who shall give all necessary assistance for establishing benches, plugs, and making measurements. The contractor to call the attention of the commanding officer to any discrepancy observed by him between lines staked out, or otherwise fixed, and the plans.

The contractor, at his own expense, must conduct the water away from any point where masonry is being laid, by the use of trenches, pipes, or other efficient means, and must prevent water from flowing over the masonry till it is fully set. Under no circumstances shall masonry be laid in water.

Brick masonry.

Contractor to furnish all brick masonry in walls, piers, and chimney, as shown on plans.

The brick masonry of all exterior walls to commence on top of the rubble masonry, and of all other walls and piers on a bed of concrete, except where shown otherwise on plans.

All brick-work below the floor-line to be laid in best hydraulic cement and rock-lime mortar, mixed in the proportion of one part cement, one-half part lime, and two parts sand, properly mixed, as much at a time as can be used before setting; no cement mortar to be used after it had been once set.

Said cement mortar to be used to a height in level with the floor-line of the building, at which point the last course shall be evenly and smoothly pargetted over with cement, forming a damp-proof course, before remainder of brick-work is started.

The brick shall be of best quality of hard-burnt bricks, burnt hard entirely throughout, regular and uniform in shape and size, and of compact texture. To insure their good quality, the bricks furnished by the contractor will be subject to inspection and rigorous tests, and if found of improper quality will be condemned; the character of the tests to be determined by the commanding officer.

No bats shall be used without his permission, but nothing smaller than half bricks.

All brick-work above the floor-line, except the cornice, to be laid in mortar made of domestic cement of approved quality, best hydraulic rock-lime, and clean sharp sand of coarse grain, in the following proportion: One-half part of cement to one part of lime and two parts of sand. The mortar to be well and thoroughly mixed. No air-slaked lime to be used. The bricks thoroughly wet just before laying. Every brick to be completely imbedded in mortar. Care shall be taken to have every joint full of mortar. Competent mechanics shall be employed for this work. All bricks shall be laid close, straight, and plumb, well flushed in and properly bonded with one course of headers to every six courses in height. Facing-bricks to be uniform in color, and all joints on exterior of walls to be neatly pointed with black mortar. Joints in arch-work not to exceed one-fourth inch.

Brick arches to be turned over all doors, windows, and other openings, as shown on plans. All arches to be triple arches, 12 inches high.

Flues to be located in middle pilasters of east extension. Sizes are shown in plans. They must be uniform in size throughout, neatly and smoothly pargetted on inside, and left clear at completion of building.

Contractor to hoist in place and build into walls all I-beams to go into window and door openings, as shown on plans. He will also hoist in place and locate on cast-iron plates the ten I-beams forming the support for the second floor of the east extension. Four of such beams to be anchored into walls on both ends. All I-beams, anchors, and plates will be furnished by the Ordnance Department. Double arches (8 inches thick) to be turned between the above beams and top of arches to be filled up to the top of beams with concrete.

One wrought-iron anchor, 4 by one-half inch, to be laid into each north and south wall of engine-room, through their entire length, commencing in center of wall of main aisle and reaching 10 feet into walls of boiler-house. Said anchors to have bolts, 2 inches diameter by 3 feet long, on each end, and to be located on top of wall, just below cornice.

All gable walls (north and south wall of main aisle and west wall of boiler-house) to be anchored to purlins of roof at intervals of 6 feet by wrought-iron anchors 2 by three-eighth inch, built into middle of walls. The six pilasters on east elevation and all cornice projecting above roof to be securely anchored to roof by anchors 2 by one-half inch.

All cornices are of brick-work, and to be built as shown in elevations and in details.

The two middle pilasters of east elevation have two belt courses of cut stone each, the corner pilasters one course. There are belt courses of cut stone in level with lower window-sills, all along east front of central section, along north front of main aisle, and in all corner pilasters of building.

Brick cornice to be well bonded, neatly built and pointed up, and to project 13¾ inches from face of pilasters on east front of central section, 12¼ inches on main walls of north wing, and about 6 inches on walls of east and west aisles.

All walls projecting above roof to be cemented with neat cement from under side of capstone to top of tin flashing. Same to be made waterproof.

Contractor to set and anchor all cast-iron shoes for roof-trusses, girders, beams, and braces wherever shown, and bed them properly in cement. They must be level and firmly secured. All openings in walls, in connection with such castings, to be made as shown.

Foundation-bolts and washers to be built into brick piers of crane columns, as shown on detail drawings. They must be placed carefully, by means of a templet, and in proper height for the cast-iron base-plates to be screwed down. The space in the pocket around bolts to be cast out with pure cement to top of brick-work.

All walls at the back of the cornice, at the bottom and the side of gutter, to receive a thick coat of best Portland cement, to form a cement gutter beneath the wooden one. Pieces of ¾-inch wrought-iron pipe to be built into cornice from the bottom of the cement gutter to the outside, at intervals of 6 feet, as shown in detail.

The cemented gutter is to be made water-tight by putting all over it a heavy coat of asphalt. The chimney must be built carefully, with joints not exceeding one-quarter inch. It is to be topped out as shown, in cement mortar, as specified for foundation walls. Treads of ⅞-inch round iron to be securely built into brick-work on the inside, every 20 inches in height from bottom to top, to give access to the latter. The bricks forming the corners of the octagonal part on the outside to be of special shape. The fire-brick lining, as shown, is to be laid in a mortar of equal parts of best fire clay and fire sand. All openings in chimney to be built as shown, the exposed faces of such openings to be of fire-brick. Fastenings for lightning-rods to be built into brick-work on outside of chimney.

Anchors for securing the cast-iron cap to be built in on top; cap to be hoisted in place and properly secured and set in cement. Hoist and secure in place also the two (flue) caps over middle pilasters of east extension. Exterior and interior shafts to be well braced against each other at intervals by means of projecting bricks.

The contractor to cut out or build up after carpenters, roofers, plumbers, or other contractors, everything necessary to complete the building.

The contractor for the carpenter work will furnish all necessary arch centers, and perform any other carpenter work that may come in his line.

The contractor is to clear the building and site from all refuse and rubbish, to do all refilling and grading about the walls, and to leave in neat condition the grounds occupied by him. He is to give all facilities to other contractors for performing work adjoining his own, and any difference which may arise between two contractors in regard to their adjoining work is to be adjusted by the commanding officer. His decision is to be final in the matter.

It is desirable that the work of laying foundations shall commence on or before the 1st of May, 1889, and the mason work be prosecuted uniformly and steadily, and no part of any wall shall at any time rise more than 3 feet above the rest. All unfinished work must be racked back, as may be directed by the commanding officer in each case; and before new work is joined to its surface the bricks must be scraped clean, scrubbed with a stiff brush, and well moistened.

The Ordnance Department will furnish all wrought-iron anchors, clamps, hinge-eyes required, in accordance with the above specifications. The contractor is to put them in place, and furnish all cement and lead required for that purpose, except where it is specified that another contractor shall furnish the same.

The contractor is to put into walls all other anchors, plates, etc., required for the erection and completion of the building and not specified herein, if directed to do so by the commanding officer.

All walls should be finished for the reception of roofs on or before the 1st September, 1889.

All interior surfaces of walls above floor-lines to receive two heavy coats of whitewash after the building is under roof.

CARPENTER WORK.

The carpenter work comprises mainly the following items:

1. The carpenter work on roofs of main aisle, east extension, boiler-house, and engine-room.
2. The carpenter work on roofs of east and west aisles and west extension.
3. The work on second floor of east extension.
4. The work on ceilings of office in west extension and instrument room.
5. All exterior and interior doors and windows, as shown in plans, sections, elevations, and details, or otherwise specified.

All framing lumber, as purlins, joists, etc., to be of good quality, mill-sawed, square-edged, straight, sound, dry yellow or white pine lumber, free from loose knots, rot, or any imperfections that will impair its usefulness or strength. All purlins of main roof, east extension, and boiler and engine house to be laid on iron trusses, spaced, as shown on drawings, and fastened to iron angles by two ⅝-inch screw-bolts, or otherwise, if so directed.

All purlins, which form one string, to be scarfed together above iron rafters. Scarfs up and down not less than 8 inches long, and bolted together with two ⅝-inch screw-bolts passing through the angle. Washers under all bolt-heads and nuts. Screw-bolts and washers to be furnished by the contractor for the iron-work.

Purlins at north and south walls, and at west walls of boiler-house, to extend 4 nches into said walls, and to be anchored to same every 6 feet by wrought-iron anchors 2 by ½ inch. Anchors to be spiked to purlins with three ⅜-inch wrought-iron spikes 3 inches long.

All purlins for main aisle and east extension roofs to be 4 by 8 inches and at least one-half of them to reach over two bays; care to be taken to break joints in the direction of the slope of the roof. All purlins for east and west aisles, west extension, and boilers-house to be 6 by 7 inches. Lumber for purlins of boiler-house and engine-room, and also for 400 purlins, each 18 feet 6 inches long, of east and west aisles, will be furnished by the Ordnance Department.

The roof-trusses of east and west aisles and of west extension, to the number of 51, are shown on drawings in detail. The main rafter to be of yellow pine lumber, to be furnished by the Ordnance Department. The posts and horizontal braces are of oak umber, which will also be furnished by the Ordnance Department. All connections to be made as shown.

Screw-bolts and cast-iron washers for connecting posts, braces, and rafters will be furnished by the Ordnance Department. All other bolts in connection with cast-iron shoes, etc., will be furnished by the contractor for the iron work. Purlins to be spaced as shown on drawing, and to be notched into rafters. Each purlin to be well nailed to rafter. All purlins forming one string to be spliced. Splices to be above russes, to be 6 inches long, and to have one ¾-inch screw-bolt going through both pieces, washers to be under heads and nuts. These bolts and washers to be furnished by the contractor for the carpenter work. He is also to furnish three wrought-iron angles for each truss. Angles and their location are shown in detail. Each angle is spiked with two ¼-inch nails to rafter, and with two nails of the same size to the ratter against which it lies. Nails to be not less than 3 inches long.

When the purlins differ in depth they must be notched so as to bring the upper surfaces of purlins to the same level.

Where purlins terminate at walls, they must be securely anchored to walls every 6 feet; anchors to be furnished by the Ordnance Department. All roofs to be covered with sound 1¼-inch white-pine boards, tongued and grooved, averaging 8 to 10 inches n width, driven up close, and nailed to each purlin through each edge and center. Said roofing to be dressed on one side to a uniform thickness before being laid.

Roof-boards to finish at eaves as shown on detail drawing of gutters. Gutters to be made of dry 1¼-inch boards securely nailed together and constructed as shown. Gutters must be well supported on walls, well made, and properly drained to down-pipes. Care must be taken not to injure the cement and asphalt lining of brick gutters.

All framing on and around sky-lights and ventilator of main roof, and sky-light in roof of engine-room, to be done as shown in detail drawings. All roofs to be ready for the slater and tinner on or before the 15th of October, 1889.

A scuttle is to be formed in truncated roof of east extension, size 24 by 36 inches, with framed curb; hinged cover fitting closely around said curb, with hook on under side.

The floors of offices on second floor of east extension to be made as follows: Strips of wood, 2 by 3 inches, to be laid into cement over brick arches, one strip on each side of each wrought-iron beam and one on each side of partition walls. Said strips to be flush with top of beams. Single flooring to be of 1¼-inch, narrow width, tongued and grooved, bright-yellow pine, secret nailed.

Flooring on gallery in front of offices and on landing of lower flight of stairs (as shown in drawing) to be of same material and to be properly fastened.

Ceiling and offices of second floor of east extension, in instrument-room, and time-keeper's office to have ceiling-joists of 6 by 2 inches good sound white pine or spruce, to be laid on wall-plates on second floor, and on wall-plates and framed into iron beams in the two rooms of west extension. All sheeting to be of tongued and grooved, secret-nailed, yellow-pine boards 1 inch thick.

Ridge-boards, 3 by 1¼ inches, to be on ridges of all roofs.

Window-frames and sashes.

All window-frames throughout the entire building to be made as shown on detailed drawings. All exposed wood-work to be made of sound, kiln-dry yellow or white-pine lumber, neatly dressed. All oak lumber required for the parts of a few window frames and for the railroad doors designated on the drawings, will be furnished by the Ordnance Department.

Sashes to be sliding or swinging where shown on drawings, all other sashes to be stationary. Sashes to be of heart white-pine of dimensions shown. Check-rails to be plowed and bored for chords. All glass to be single and of good quality; sizes are given in drawings.

All sliding sashes to be double hung with 2¼ inch Excelsior axle-pulleys and Silver Lake sash-cord, No. 8, and to be properly balanced with lead or iron weights.

All swinging windows to have stout swivels, fastened on inside of sash, about 4 inches above its middle, also spring-catches on the bottom rail and proper arrangements for holding windows open, and galvanized-iron flashings on outside of bottom rail to drain off the water.

All window frames to be provided with iron fasteners, to be built into brick-work, as shown on plans.

All window-frames to be ready and to be set in place by the contractor as soon as the window-sills are set, so as not to cause any delay in the erection of the brick walls.

Doors.

All door-frames and doors to be of size and to be made of such lumber as shown on drawings. All exposed wood-work to be of sound, clear, well-seasoned, dry, yellow or white pine or oak lumber. Wooden door-frames to be well anchored to brick-work with light iron anchors, 2 feet apart (three or four to each jamb). Ends to be doweled to stone sills.

The door-frames of the five doors of offices on second floor of east extension, and of those two in partition wall between engine and boiler-house, to be 2¼ inches thick; width of frame to be full thickness of wall. The doors to be of heart white pine, four panels, 1⅜ inches thick, double molded. Upper panels to be glazed with ground glass in offices on second floor, and with common glass in engine-room. Doors to be hung in broad loose joints, wrought iron butts and hinges. All outside doors to have stout bolts top and bottom, square spring pattern, appropriate to size and kind of door. Patterns and sizes to be approved by the commanding officer. All outside doors to be hinged with heavy wrought-iron hook-and-eye hinges. Hinges to reach clear across doors, and for the larger doors and the three railroad doors to be 4 by ½ inch iron, and to be fastened with ⅝-inch carriage bolts not more than 8 inches centers. Four such hinges to each wing of railroad doors, the other doors to have three hinges to each wing. The bolts for railroad doors must be lever-bolts, of especially heavy size and special form, to be approved. An iron cross-bar must be arranged on inside, to keep these doors securely closed, and hooks, to secure them in the open position. The two railroad doors for main track to have a heavy iron grating at the bottom. All double doors to have stout bolts, square spring pattern, for stationary half. All other outside and inside doors with wooden jambs to be hung with broad, loose joint, wrought-iron butts and hinges, three to each wing.

Office doors on second floor to have mortise-locks, bronze knobs, and triplicate steel keys. All other outside and inside doors to have rim-locks with triplicate keys, and stout wrought-iron handles and latches on both sides, all of approved sizes, quality, and pattern. All door-frames must be set in place by the contractor in time for the mason to build them into brick work. Contractor to furnish all ridge-boards, ⅞ by 1½ inches, in place, as shown in detail. All doors and windows must be complete in every respect. All window and door frames and sashes to be primed with a coat of white oil paint (white lead in linseed oil) before being delivered on the premises.

The contractor for the carpenter-work to furnish all screw-bolts, screws, anchors, spikes, nails, etc., required for the execution of its contract, except where otherwise specified. He is to furnish also all necessary centers for arched openings, and perform any other carpenter-work that may come in his line.

IRON-WORK.

The *materials to* be used in the construction to be of iron, mild steel, etc., as specified, and all the iron and steel to be of domestic manufacture.

All plating is to be of mild steel or wrought-iron, which must have a tensile strength of at least 50,000 pounds per square inch of original section and a final elongation in 8 inches of not less than 23 per cent.

The I-beams, channel-bars, angle and tee-bars to be of wrought-iron or mild steel of the same tensile strength and ductility as the plates.

All castings to be made of the best quality pig-iron.

The minimum weights and sizes of all metal parts are shown on the plans, and any materials delivered at the buildings which are not of the prescribed weights or sizes *will be rejected.*

All pin-holes of pin-connected trusses to be very accurately spaced, the distance between outsides of holes in tension members to be $\frac{1}{32}$ inch less than the figured distance between outsides of finished pins; and the distances between insides of holes in compression members to be $\frac{1}{32}$ inch greater than figured distance between insides of finished pins.

All pin-holes to be drilled on axes of members, and to exceed in diameter those of the finished pins by not more than $\frac{1}{32}$ inch.

Heads of all eye-bars to be formed of dimensions as shown on drawings, and the process of manufacture to be approved by the commanding officer.

Threads of all screw-ends to be up-set, after screwing up nuts, to prevent the latter from working loose.

On one side of splice-plates of girders of crane-bridge must be dilatation holes, of larger diameter than that of bolts (as shown in details). The corresponding holes in web of box-girder to be concentric with the dilatation holes of the splice-plates, and to be drilled and tapped for the connecting bolts. The joints between box girders are not close, to provide for expansion.

Dilatation holes are provided in all beams and girders, connecting crane columns and girders with the roof of side aisles and walls of building.

The metal of all parts of castings to be uniform and of thickness shown in drawings. The castings must be sound and free from flaws, blow-holes, etc. Surfaces to be true and straight.

Bolt and rivet holes to be drilled or cored; no chipped holes will be allowed. All surfaces must be faced which are designated so on drawings, or necessarily to be faced to make the construction perfect and complete.

All surfaces of castings bearing on stones must be planed. Tops of base-plates of columns of crane-bridge to be also planed true and paralel with bottom surface. These plates must be uniform in thickness and must be carefully bedded.

All surfaces of contact between metals, not designated to be faced, must be even and properly chipped. In all cases the bearing must be full and true.

All columns must be set plumb on true beds.

All girders and beams to be set level, except otherwise directed.

Rails for traveling-cranes to be of rolled steel; their shape and connection with girder-boxes are shown on drawings.

Foundation bolts of crane columns to be leaded in holes of cap-stones.

All brace-rods to be of "Burden" H. B. & S. iron.

Rivets to be of best quality "Burden" iron.

The diameter of rivets must not be more than $\frac{1}{16}$ inch smaller than the hole they are to fill.

Rivets to be heated to a uniform light-red heat before driving. No drift-pins must be used; holes to be reamed out till true.

All rivets, when driven, must completely fill the holes and have full heads, well formed. Sizes of rivets are given in the drawings.

Bolts to be furnished wherever shown in the drawings or called for in these specifications, or otherwise necessary for the completion of the work. Washers under all nuts, and under heads where necessary.

All iron parts to receive one coat of good mineral paint in pure linseed oil after inspection, before leaving the shop, and, in addition, all parts inaccessible to painting shall receive a coat of paint before being assembled together.

After erection and approval they shall receive a final heavy coat of the above paint, except the iron work or ventilator, sky-lights, chimney and flue-caps, which shall receive two coats.

Contractor to erect all false-work, scaffolding, derricks, hoists, etc., necessary for the prosecution of his work, and he assumes all liability in case of accident to men or material.

The workmanship on all material must be first-class in every detail, and any work objected to must be made satisfactory.

The contractor is to furnish, erect in place, and finish the following:

1. Thirty-two trusses for main roof, with sliding and stationary shoes and all other castings, as shown on drawings.

Thirty-four cast-iron angles, as per detail, to be furnished and secured to each truss.

Two $\frac{3}{4}$-inch screw-bolts with washers to be furnished to each of such angles, of ample length to fasten 4 by 8 inch wooden purlins to same. There need not be such angles on a part of east branch of the two middle trusses over central section, under intersecting roof, where no purlins are required.

2. Three trusses, one trussed girder, and two valley rafters for intersecting roof of east extension, with all castings, angles, braces, etc., and all other parts, shown in drawings, to complete the structure.

3. One iron ventilator with glazed roof, and an iron sky-light on each side of ventilator, as shown in drawings and details; all to be complete, except glass and felt.

4. Four main trusses for boiler-house roof and two valley rafters, and two small trusses for intersecting roof over engine-room. Iron sky-light in this roof. All shoes and other castings (as angles for purlins, etc.) and bolts and braces to be furnished to complete roof, as shown in drawings.

Contractor to put all roofs, specified in items 1 to 4, inclusive, in place, and to put on all wind-bracing as shown. Everything must be completely finished for the carpenter to put on purlins and roofing.

5. The iron-work for the roofs of east and west aisles and west extension.

There are 51 trusses, their construction being combined of wood and iron.

These trusses are connected with the columns of bridge of traveling-crane by girders formed of two I-beams, while the upper braces connect the box-girders with the upper rafter-shoe in east and west aisles and in the west extension. In the central section the lower and upper brace-beams are connected with cast-iron shoes built into the wall.

The two lower brace-girders next to the north and south of chimney are of heavier size.

Their ends lie also in cast-iron shoes.

All cast-iron shoes or plates resting in walls of building must be furnished at the proper time to avoid delay in the construction of the walls of the building. Except these castings, the contractor is to hoist all iron-work in place, and to assemble and finish the construction.

6. The two flights of iron stairs leading to the second floor of central section, with all necessary beams and other iron-work to complete landing and upper gallery in front of offices, all as per drawings, complete and erected in place. A railing of wrought-iron or of 1½-inch pipe is to be made on gallery and landing where shown in drawing.

7. All iron-work for the traveling-crane bridges, columns, girders, braces, etc., all complete, finished and erected.

8. The cast-iron cap for top of chimney, with all anchor-bolts and bolts for connections; also the cast-iron caps for the two middle pilasters (flues) of east extension complete.

Contractor to furnish any iron-work which is not specified as to be furnished by the Ordnance Department or another contractor. All iron-work on and about roofs should be finished on or before the 1st of November, 1889.

Roofing, tinning, gutters, rain-leaders, sky-lights, lightning-rods, snow-guards.

All roofs to be covered with No. 1 Chapman slates, or equal, size 8 by 16 inches Slates to be strong and heavy, and to be laid 6½ inches to the weather.

Bidder to furnish a sample slate on which his bid is based.

All slates to be nailed on with two 4*d.* copper flat-head slate-nails to each slate. The ridges to have a galvanized-iron (No. 24) ridge-roll. Roll to be 4 inches with an 8-inch apron on each side, which is turned down over edges of ridge board, as shown in detail, and securely nailed to said edges.

All valleys to be tin, not less that 20 inches wide, painted on both sides with two coats of metallic paint before laying them on building. Top course of slate on all ridges and one foot on each side of all valleys to be laid in oil-cement. All flashings about walls projecting above roof to be of zinc, also those about chimney. All flashings about walls, etc., to be counter-flashed and cemented into joints of brick-work. All hips cut and made a slate finish, and bedded in oil-cement.

Gutters on building to be lined with tin, and made as per detail drawings.

Tin painted with 2 coats of metallic paint on under-side before laying. Gutters to have copper spouts, leading into conductors, of 16-ounce copper, with hub fastened to lower end and calked with lead into the conductors, as shown on details. Furnish one galvanized-iron screen basket for each down-fall.

Conductors to be of cast-iron, 5 inches interior diameter.

Conductors to run down on inside of walls of building and to be properly secured to same by wrought-iron hooks. Two conductors to lead down, at junction of east extension and main wall, from roof-gutter to top of water-table, and there to pass through wall of building to the outside, projecting at least 6 inches from line of wall.

Twelve conductors to lead down from gutter of main roof to a point in line or slightly above window-sills of upper tier of windows, and there to pass through wall, projecting 6 inches at least from face of wall. Fifteen conductors to lead down from gutter of lower roofs to a point slightly above water-table, where they shall pass through walls and project on outside at least 6 inches from face of walls. All connections in conducting-pipes must be well made and perfectly water-tight, and all such pipes must be well fastened to walls with iron hooks and secured to prevent any of them from sliding down.

Flashings about iron ventilators and sky-lights of main roof and of engine-room to be made, as shown in detail, of 16-ounce copper.

Cover of scuttle of roof of east extension to be tinned with best quality tin, IX

ıl brand, securely nailed. Flashing to extend around entire curb, running up
ır the top of same, and to be made perfectly water-tight. Contractor to fur-
'ought-iron galvanized anchors, to anchor coping-stones in front of all gutters
Such anchors to be of sizes and shapes as shown in detail; one end to be
, and to be let into recesses of coping-stones at least 1½ inches deep, and to
ıerly leaded into same. The other end to pass into roof, and to be fastened
in by one one-half-inch lag-screw and one three-eighth-inch wrought-iron
ıs shown in detail. Anchors to be made perfectly water-tight where passing
ı roof. All gutters of main roof to be provided with snow-guards, as shown
'ing. The wrought-iron standards of said guards to be 6 feet apart on roof,
ıe securely riveted to every one of the aforesaid anchors and to be galvanized.
holes, for securing board-walk over gutters, to be provided in anchors. Screw-
ıd board-walk to be furnished by the Ordnance Department.
ıop rail is made of 1¼-inch wrought-iron pipe, in suitable lengths, and provided
:pansion connections, as shown. All braces and everything belonging to snow-
to be properly painted, same color as gutters.
htning-rod is to be placed on ridges of main roof, intersecting roof of east
on, and ridges of boiler-house roof and of intersecting roof of engine-room.
;htning-rod to pass over entire length of ridges, and is to be a copper cable-
l, one-half inch, 7 strands, well fastened up. Points and tips to be arranged
h and south walls of main roof and at intermediate points, 100 feet apart, also
le wall of boiler-house roof.
:ning-rods to lead to ground at four places (from north and south end of main
ıd east and west end of east extension and boiler-house) and to terminate in
plates, put under ground, 5 feet below the surface.
ightning-rod to be put on chimney, with point and tip. Same to lead down
;round independently, and to terminate in a copper plate below ground, as
d.
ınings on roofs to be insulated.
:actor to furnish all such fastenings for lightning-rods as go into walls to the
tor for the masonry in time to build them into brick-work.
ontractor to furnish and put into place all sky-light glass, ¼-inch thick, ribbed.
ass to be 18 by 48 inches, except two courses in sky-lights of main roof, where
ss is only 9 inches wide. The glass is to be put in place and to be made per-
vater-tight with felt, soaked in oil, as shown in detail drawing. Contractor
sh and secure proper copper ridge-pieces, and make sky-lights and ventilator
te and water-tight.
ıofs to be covered with 3-ply ready-roofing (No. 2 tarred roofing-felt, laid to
east 2 inches), well tacked down before laying on slates.
to put under all tin one thickness of the heaviest red rosin-sized paper before
tin.
n to be used to be "old style" brand roofing-tin, in sheets 14 by 20 inches, well
lown, and soldered heavy with strictly half-and-half solder.
in gutters are to be made as shown in detail, and the apron is to be let into a
ın top of coping-stone throughout and to be well leaded in.
ımpletion of all work the roofs will be inspected and must be found in perfect
on. All work must be done in a good, workmanlike, and proper manner
hout, and roofs warranted for one year.
ıe above roof, etc., to be completed on or before the 1st of December, 1889.
:ontractor will also submit a bid for furnishing the above work with the sub-
ın of 16-ounce sheet-copper wherever tin or zinc is called for in the specifica-

Painting.

'indow-frames and sashes, also all door-frames and doors, must be painted on
ide and outside with two coats of dark-red paint, made up with linseed oil.
o be selected by the Ordnance Department. Bidder to state kind of paints on
his bid is based.
'ood-work on offices of second floor, including ceiling, to be properly painted
ıral colors.

Bids will be received for the following items:

I. All stone, brick-masonry, and concrete, exclusive of furnishing cut stone
ıne blocks for the foundation of chimney, but including whitewashing the
Also grading around walls of building.
II. All cut stone and stone blocks for foundation of chimney, inclusive of all
; necessary on said stone as specified, delivered at the building.
III. All carpenter-work, exclusive of door and window-frames, sashes, and

Item IV. All window-frames, door-frames, sashes, and doors, complete in place, glazed and primed.

Item V. All iron-work, except that to be furnished by the Ordnance Department or other contractors, as specified.

Item VI. All slate roofing, tinning, gutters, rain-leaders, sky-lights (except iron-work of same), lightning-rods, and snow-guards.

Item VII. Painting of windows and doors, and offices on second floor.

Bids will be received for a single one of the above seven items, or for one or more items, or for the work embraced in the seven items as a whole.

2.—SPECIFICATION FOR TWO DWELLING HOUSES FOR OFFICERS' QUARTERS TO BE ERECTED AT THE WATERVLIET ARSENAL, N. Y.

MASON'S SPECIFICATIONS.

Dimensions.

All dimensions and distances to be as figured on the drawings. Work by the figures given on the scale drawings and by the full-size detail drawings.

Excavation.

The cellars, areas, and holes to receive piers to be excavated the required dimensions in the earth and rock.

The earth to be well filled in around all foundations on the outside up to the present grade-lines, and well rammed.

As much of the excavated earth as will be needed for grading around the houses to be deposited on the premises where the inspecting officer will direct. All superfluous earth and all excavated rock, and all rubbish of every kind which accumulates in and around the buildings, to be carted away.

Stone masonry.

The outside foundation walls of the buildings to be 20 inches thick, and to extend up to first-floor timbers and to the cut-stone water-table.

The walls of the two areas to be 18 inches thick and to extend up to the grade. To be 29 piers, 20 by 20 inches, under piazzas, porches, and outside steps, said piers to commence on the rock and to extend up to the grade-lines.

The above work to be of good building stone from the old Arsenal building, well laid in mortar made with sharp sand well mixed with equal parts of cement and lime. All work to be well bonded, all joints filled, and all exposed joints to be neatly pointed. The outside face of all stone walls above the grade, except under piazzas and porches, to be of selected stone, having straight faces and horizontal and vertical joints, pointed with stone-colored cement and jointed. Said work to be of the old Arsenal building stone, laid in courses, or in the form of broken ashlar.

Brick-work.

The division walls of cellars to be 8 inches thick and to extend up to under-side of first floors. The outside brick walls to be 12 inches thick, and to be anchored to the second and atic floor timbers with ½ by 2 inch wrought-iron anchors, placed every 5 feet 4 inches, and secured with three spikes each, and said anchors to turn up 4 inches at the outside ends, 4 inches from the outside face of walls. To be ½-inch wrought-iron coping anchors, 2½ feet long, built in the top of walls—every 4 feet to secure the wall-plates; said anchors to have heads, nuts, and cast-iron washers 2 inches in diameter. Anchors to be turned over openings, lath to be built in the inside joints of outside walls every 2 feet in height, to receive the furring, and every eighth course in all work to be headers; and all outside joints to be struck, and the joints to be struck on both faces of all brick-work of cellars.

Chimneys having fire-places and flues to be built as shown on the drawings. All flues to be plastered smooth inside throughout, and all chimneys to be plastered opposite all timbers.

The flues to have thimbles with covers in cellars and in kitchens, and one flue in each kitchen to have a black japaned ventilating register, having frame, valve, and face 16 by 20 inches, placed 6 inches down from the ceiling line. All flues to be cleaned out.

The fire-places to have mantel-bars and 4-inch trimmer arches, 2 feet wide; the ash-pits to be paved with brick and to have arched tops, and 2 by 2½ feet cast iron doors, having frames, latches, and hinges. To be openings from lower fire-places into the ash-pits, and flues 8 by 8 inches, to lead from upper fire-places to the ash-pits, and these to be plastered inside. The chimney-tops to be as shown on the elevations and to have 2-inch blue stone caps in one piece each, and having holes over the flues, and three of the tops on each house to have two ½ by 2 inch wrought-iron braces, each 8 feet long, turned up 8 inches in the brick-work, and secured to the rafters with four 4-inch lag screws.

Molded brick, No. 13, to be used to form the belts in line with the window-sills of first and second stories and the belt in line with tops of second-story windows, and molded brick, No. 40, to be used to form corners of the chimney-tops.

All other brick to be of best quality of hard-burnt bricks, burnt hard entirely throughout, regular and uniform in shape and size, and of compact texture; all those in cellar-work to be laid in cement and sharp sand mortar; the balance to be laid in good lime and sharp sand mortar, and all brick to be wet when laid. No soft brick to be used in any outside work or in any work of cellars, and the outside face brick to be selected, and the mortar in all outside face work to be colored black.

In the front of each house to be an ornamental terra-cotta panel 2 feet 8 inches square, of Glens Falls make.

Brownstone-work.

The following work to be of Connecticut brown stone, viz: Water-table, 7 by 8 inches, with 3 by 5 inch wash, extending around main part of the building, except opposite piazza; sills 8 by 15 inches, with ½-inch wash to the three outside doors of first story; sills 8 by 6 inches to windows of first and second stories; lintels and arch-stone 6 inches thick to windows, as shown on elevations; lintels 6 by 13 inches to the front doors of first story; lintel and sill to a panel in second story of front; jamb-stone 4 inches thick to two windows, and two 4 by 8 inch belts in each chimney-top.

The water-table, door-sills, and the beds, soffits, wash, and jambs of all other work to be cut and rubbed smooth; the balance of the work to be pitched rock face. The water-table, belts, and all sills to be set on the natural bed of the stone; all said rock to be of sound stone, and to be well set in red cement, anchored, pointed, puttied, and cleaned.

Blue stone.

The following work to be of sound quarry-axed North River blue stone, well set in cement, pointed and cleaned, viz: Sills 3 by 6 inches, and lintels 4 by 8 inches, to all cellar windows; sills 3 by 12 inches, and lintels 4 by 8 inches, to outside doors of cellars. Coping 3 by 12 inches on walls of areas; steps, having 3 by 10 inch treads and 3 by 5 inch risers, in the two areas; and twenty-nine stones 3 inches thick and 20 inches square on the stone piers under the piazzas, porches, and outside steps.

Plastering.

All walls, ceilings, and partitions in first and second stories to be lathed with seasoned spruce lath, well nailed, and breaking joints every 18 inches, and to be plastered three coats—scratch coat, brown coat, and hard-finish; the mortar to be well mixed; all lime to be thoroughly slaked and screened, and the mortar of the scratch and brown coats to have a proper proportion of hair, and the hard-finish coat to be well pointed after the wood-work is finished. The ceilings of parlors, libraries, main halls, and dining-rooms are each to have a 3 by 4 foot ornamental stucco center-piece, well put up.

All plastering in first and second stories to extend to the floors.

Cement floor.

The floors of all cellars and of store-rooms to have a 3-inch coat of cement, sand, and gravel grout, made level and solid, and troweled smooth on top.

Grates, etc.

The six fire-places of each house to have cast-iron linings, brass faces, portable or dumping grates, and irons and tile hearths, the whole costing, when set complete, $225 for each house, and said furnishings to be selected by the commanding officer.

Iron girders.

To be in each house a wrought-iron girder 12½ feet long, made of two 6-inch rolled beams weighing 40 pounds to the yard, and bolted together with three ½-inch bolts through cast-iron separators.

Said girders to be placed in south wall over the openings from parlors to bay windows.

Condition.

All work and materials to be of the best quality, free from all defects, and to be put into the buildings at the proper time, so as to cause no hurtful delays, and to be protected from all damages until the houses are completed, and the entire work to be completed to the satisfaction of the commanding officer and in accordance with the drawings and specifications made by the architect, who shall decide all questions relating to their meaning.

CARPENTER'S SPECIFICATIONS.

Dimensions.

All dimensions and distances to be as figured on the drawings. Work by the figures given on the scale drawings and by the full-size detail drawings.

Timber and framing.

The joists of first and second floors to be 2 by 10 inches and those of attic floor to be 2 by 8 inches. All to be placed 16 inches from centers, and trimmers and headers of double joists to be framed around chimneys and stairs, and no timber to be placed within 3 inches of the brick-work of chimneys, and each length or span of timbers to have two rows of 1¼ by 3 inch X bridging between bearings, well nailed. The joists in the space occupied by main hall and dining-rooms in all floors to extend east and west; all other floor-joists to extend north and south, and all the timbers to be well spiked on partitions.

The roofs to have 2 by 10 inch hip and valley rafters and 2 by 8 inch common rafters, placed 20 inches from centers, and well spiked at all bearings and intersections, and each pair of rafters to have a 2 by 8 inch collar-piece spiked on. The rafters to rest on 6 by 6 inch posts in attic, and those to stand on 6 by 6 inch sills 4½ feet long resting on the attic-floor timbers, and all well spiked, and the posts to be stayed to each other and to the rafters by the collar-pieces, which are to be spiked to them. The wall-plates to be 2 by 12 inches, halved and spiked together at all angles, corners, and splices. The decks or flat portions of roofs to have 2 by 10 inch joists 20 inches from centers, framed into 4 by 8 inch girts resting on the 6 by 6 inch posts of attic, and the whole well spiked, and the decks to be furred up with 2-inch pieces to give them pitch, as shown on section drawings. The gables and dormers to have frame-work of 3 by 4 inch studs placed 16 inches from centers and well nailed.

All partitions in first and second stories to be of 3 by 4 inch studs, placed 16 inches from centers, and well nailed, and having double studs each side of all openings and three in all angles, spiked together, and the partitions to be trussed over all sliding-door openings. And each partition to have one row of 1¼ by 3 inch X bridging.

To be seasoned lintels 8 inches high over all openings in walls.

All timber to be of hemlock or spruce, except studs, which are to be of hemlock, and all timber to be sound and square-edged.

To be an 8 by 9 inch girder in each house under the first-floor joists that extend into the bay-window.

Roofs and outside finish.

All roofs and the tops and sides of all dormer windows to be boarded with sound seasoned 1-inch gang-sawed hemlock boards, well nailed edge to edge, and the decks of main roofs and the roofs of piazzas, porches and bay-windows to be covered with 14 by 20 inch tin put on flat, nailed four nails to a sheet, and to have double-tin flashings under slate and cemented in walls, and the decks to have a molded wood finish at their eaves, and the tin to form a drip over this finish. All steep portions of roofs and the tops and sides of all dormer windows to be covered with first quality of unfading black Pennsylvania slate 8 by 16 inches, put on one thickness of felt with tinned nails, and to have double flashings of zinc around all chimneys and dormer windows and wherever necessary. All valleys to have tin linings 20 inches wide. All ridges to have wood-saddles and beads well nailed on, and the highest ridges to have wood crest and finial as shown, well secured, and all hips to be formed with cut slate, bedded in cement and cemented in the hip-joints. To be gables formed back of chimneys, at an angle of 45°, and these to be covered with tin, well nailed, soldered, flashed and cemented. The horizontal cornices in all gables to be boarded on top, and covered with tin and made tight.

All tin used to be M. F. or old process. All cornices of eaves and gables to be of wood and molded and made as shown on elevations, and to have brackets; the gables to be boarded with seasoned ⅞-inch matched boards, and to have bands, bars, braces, pediments, and spaces covered with clear pine shingles 5 inches wide and having cut corners. The overhanging timbers of attic under north gables to be ceiled underneath with ⅞-inch matched and beaded boards 4 inches wide, and to have large brackets. The outside finish of all dormer windows and gable windows to be as shown on the drawings, and furring-brackets and blocks 1¼ inches thick to be provided to receive all outside wood-work, and these to be placed 20 inches from centers, built in walls, and spiked on the timbers.

The piazzas and porches to have 8 by 8 inch sills resting in walls and on 6 by 6 inch chestnut posts, standing on the stone piers, and to have 2 by 8 inch floor-joists and rafters 16 inches from centers, ceilings furred level and formed with ⅝-inch matched and 3-beaded boards 3 inches wide, blind-nailed, and having a molding in all angles; the floors to be of clear 1⅜-inch strips, 3¼ inches wide, jointed and nailed ¼ inch apart, and to have molded nosings; the columns to be of whitewood, square in porches and turned in piazzas, and the turned columns to have caps, bases, and pedestals. The cornices, railings, and bases to be as shown, and the outside of the porches and piazzas below floors to be boarded with sound 1-inch hemlock boards nailed to 3 by 4 inch studs standing on a 3 by 8 inch sill, and shingled with clear sawed pine shingles, shingles 5 inches to the weather.

All front and side stoops to have 1⅜-inch treads, nosings, coves, and risers, 3-inch rough strings, molded base—shingled ends—and railings, having newels, rails, and balusters, as shown. All the above work to be made in accordance with the elevations and the full-size detail drawings.

The bay-windows to have molded cornices and 2 by 8 inch roof, joists 16 inches from centers, and the ceilings to be furred level with those of parlors. The rear stoops, 1⅜-inch treads, nosings, coves, and risers, and buttresses having caps and bases.

Floors.

The first-story floors to be laid (after plastering is done and the base and wainscoting is finished) with best clear seasoned Georgia-pine flooring 2¼ inches wide, matched and blind-nailed, said flooring to be comb-grained and to be laid on an under flooring of sound seasoned matched spruce boards, well nailed; and said Georgia-pine flooring to be covered by temporary boarding and protected from soiling until the houses are finished.

The floors of second stories and attics to be laid with the first quality of seasoned matched ⅞-inch spruce flooring, 4 to 6 inches wide in second stories and 8 inches wide in attics, the whole well nailed, and the floors in second story to be deafened by laying an under flooring of seasoned ⅞-inch matched spruce boards, and these to be well nailed, and between the two thickness of flooring *to* be two layers of Gordon's deafening paper. All floors to be planed smooth.

Furring.

The inside of walls in first and second stories to be furred out for inside blinds to the windows where indicated on the plans, with 3 by 4 inch studs placed 16 inches from centers, and well nailed and bridged the same as partitions, and double studs to be placed each side of all openings. The inside of the balance of outside walls, in first and second stories, to be furred with 1 by 2 inch spruce strips placed 16 inches from centers and well nailed. All other needed furring to be done.

Windows.

The windows of cellars and attics, and one double window in front hall of each house, to have 1¼-inch plank frames, rotated, 2-inch sub-sills, and 1¼-inch sash, having butts, and bolts, and hooks, and staples, for those in cellars, and all cellar windows to have strong outside wire screens in frames held by inside hooks. All other windows to have box frames, 1½-inch sash, iron weights, axle-pulleys, braided cotton cords, and bronze sash-locks, and two bronze sash-lifts each; and all windows of first and second stories, (except those in front halls of said stories), and one blank window to have 1¼-inch outside blinds, having rolling slats and good hinges and fastenings, and on double windows said blinds to be in four folds and hung to the wall sides and not to the mullions.

The windows of parlors, libraries, dining-rooms, and in the chambers over these rooms, and in rooms over front halls, to have ⅞-inch inside blinds, made in four folds to each single window and to each half of double windows, and cut at meeting rails, and said blinds to fold into pockets, and to have bronze butts, hooks, and knobs.

All windows to have plain jambs and soffits, and all to have molded stools and aprons, except the windows of the parlors, libraries, dining-rooms, and front halls, which are to have paneled and molded backs with two panels each and raised moldings. One north window to have an outside fan-head, and one front window to have arched head with outside transom-bar.

Doors.

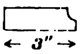
The outside doors of cellars to be 1¾ inches thick and paneled. All other doors of cellars to be 1⅛ inches thick, matched and battened, and to have jambs, plain casings, two wrought butts each, and good rim locks, with brown knobs.

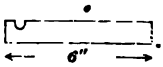
The front entrance doors to be 1¾ inches thick, and to have molded and raised panels, molded jambs, impost, head-light sash, with bronze butts and bronze transom-lifters, and said doors to have three pairs of bronze butts, top and bottom flush-bolts and chain-bolts of bronze, and first-quality bronze-faced mortise-locks with night works, and large bronze knobs and furniture.

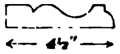
All other doors to be five-paneled and molded on the solid; the siding doors to be 1¾ inches thick, 8 feet 3 inches high, and to have hard-wood guides, jambs, astragal edges, bronze flush-pulls in the sides and edges, and to be hung complete with Barry's top hangers. The balance of doors to be 1⅜ inches thick, 7½ feet high, and to have rotated jambs, three plain bronzed, loose-joint wrought butts, and 3½-inch Niles' mortise locks with white knobs and nickel-plated furniture, and said doors to have hard-wood thresholds where needed or required. The kitchen doors to hall, marked "A" on plans, to have head-light sashes 12 inches high, screwed in over transom-bars.

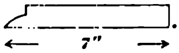
The openings marked "B" on plans to have jambs and casings like those of doors but no doors.

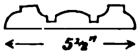
Casings, base, and wainscoting.

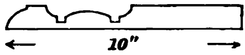
The casings and base in closets to be thus: 



. Those in kitchens, kitchen pantries, laundries, servant's rooms, back halls, and bath-rooms to be thus: 



. All other casings and base in first and second stories to be thus: 



, and these to have in the casings plinth-blocks at the floors and angle-blocks with turned buttons, and all casings and base to be ⅞ inch thick. The kitchens, laundries, and bath-rooms to be wainscoted 3½ feet high with ⅞-inch matched and three-beaded boards 3¼ inches wide, blind-nailed, and having a 3½-inch molded and beaded cap, and the bath-tubs to be ceiled up with the same boards and to have molded caps; grounds to be put on throughout to receive all plastering, and no wood finish to be put in till the plastering is dry, and all plastered corners to have wood corner beads.

Stairs.

All stairs to have 1⅛ inch treads, nosings, coves, and risers, and three 2-inch rough strings to each flight: the back stairs to have plain wall-strings and railings in atties and cellars of 1⅛ inch matched and beaded plank 4 inches wide, having 2 by 3 inch oval grooved caps, and to have side partitions of studs or of like plank in first and second stories.

The front stairs to have molded and beaded strings and skirtings, platforms of 1⅛-inch matched strips 3 inches wide, and railings having 6-inch newels and 2½-inch balusters, all turned and molded, and 3½ by 3½ inch double-molded rails, with ramps and casements at all newels.

Sundries.

The kitchen pantries are each to have wide counter shelves and four shelves over the counters, and cupboards under the counter-shelf, having doors, lids, butts, catches and lift-rings. Four shelves also at each end.

In each butler's pantry to be a case—these cases to have counter and floor-shelves—and under the counter-shelves to be three cupboards and four large draws and four small draws. Above the counter-shelves to be wide shelving having ⅞-inch matched backing and inclosed with five pairs of 1⅛-inch paneled or glazed sash-doors provided with locks and bronzed butts, bolts, and knobs, and at the top to be a 4-inch crown molding, and one section of the upper part of case to be raised 20 inches above the counter-shelf, and in this space to be a paneled slide having jambs, casings, guides, and bronzed pulls.

Adjoining all sinks to be a fluted drip-shelf supported by turned legs, and the pantry sinks to have molded wood frames and caps and turned legs; the soil-pipes to be boxed down to cellar bottoms, and the face of all boxes to be screwed on; and all wood-work connected with the plumbing to be done. Each linen closet to have four large draws below a counter-shelf and four wide shelves above, and all draws to have bronzed pulls. All other closets to have, each, two shelves and strips with clothes-hooks on three sides, and to be strips with ten hooks in each kitchen, laundry, and servant's room, and all hooks to be of the largest size, double, and bronzed. All centers needed in turning arches to be furnished by the carpenter. To be six hard-wood mantels in each house, set complete at the fire-places, and costing $175 for each house. Said mantels to be selected by the inspecting officer.

The areas or cellar-ways to be covered by 1¼-inch matched and b ened inclined trap-doors, hung by strong strap-hinges to 3 by 5-inch frame ed on 2-inch matched plank sides placed on the stone coping, and the doors tc ft-rings.

The wash-stands to have cupboards under them, having butts a hes.

Lumber.

All sash and all inside blinds to be of white ash. All wood-work ors, libraries, dining-rooms, and halls between libraries and dining-rooms to hite ash. All wood-work of first story front halls, including the main stairs and nt doors, to be of cherry; the balance of inside wood-work of first stories to be ol Carolina pine. All inside wood finish of second stories, except sash and inside bl to be of whitewood. All other lumber not otherwise specified to be of white pine, and all lumber to be well seasoned and to show clear in all work.

Painter's work.

All outside wood-work and iron-work to be painted three coats, and all inside wood-work of windows and doors in cellars and attics to be painted two coats. All to be done with white lead properly prepared and colored in three or more tints, as the inspecting officer will direct. All tin-work to be painted two coats with Prince's metallic paint. All inside wood-work of ash, cherry, whitewood, and North Carolina pine to have a coat of Wheeler's filler rubbed down smooth, and two coats of Berry's hard oil. The Georgia pine floors to have two coats of Berry's hard oil and white shellac. The outside of front entrance doors to have the coat of Wheeler's filler and two coats of spar varnish. All work to be properly puttied, and the whitewood finish in second stories to be stained cherry and mahogany colors.

Glass.

The glass in windows of front halls in first and second stories and in the head-lights of front entrance doors to be colored and figured cathedral glass, set in lead, and costing $1 per square foot. All other glass to be of first quality of American manufacture, free from smoke and all defects, single-thick, and all glass to be well tinned in, puttied and back-puttied. In the closet joining the library ground-glass will be required in the lower sash.

Plumbing.

The sinks in kitchen to be of galvanized cast-iron 20 by 40 inches, and to have iron legs; the sinks in butler's pantries to be of 18-oz. planished copper; the wash-trays to be of cement, with galvanized frames and legs; the bath-tubs, 6 feet long, to be of 16-oz. planished copper; the wash-stands to have china bowls and polished molded and counter-sunk white marble tops and 10-inch borders; the water-closets to be "Inodoro" closets, with tanks, and to be of white porcelain, with cherry seats and bronzed iron legs, and in each kitchen to be a 60-gallon Brooklyn pressure galvanized-iron boiler on an iron stand, and connected with the range.

Connection to be made with the water-main at the outside line of front wall of cellar, and a 1-inch supply-pipe to lead into the cellar of each house, passing underground below the action of frost. In each house to be ¾-inch pipe connected with the 1-inch, and passing under the bottom of cellars, and having ⅝-inch risers leading up to sinks, boiler, wash-trays, bath-tubs, and water closets, and ½-inch branches to lead to the wash-stands; and to be ¾-inch hot-water supply-pipes leading, in each house, from the boiler to the sinks, bath-tubs, and wash-trays, and having ⅝-inch branches to the wash-stands. All said supply-pipes to be of "A" lead, and to have in each house 11 stop and waste cocks, and all needed draw-cocks, which are to be of Fuller's pattern, of brass in kitchen and laundry, and nickel-plated elsewhere. To be drains of ½-inch thick cast-iron pipes laid below the bottom of cellars, and having a pitch of 1 foot in 50 feet, and to be located as shown on plans of the cellars, and to be of the sizes figured on said plans in their internal diameters. The water-closets to have 4-inch cast-iron soil-pipes connected with said iron drains, and said soil-pipes all to lead up 2½ feet above the roofs, and to have tin flashings and 4-inch globe ventilator tops; and all soil-pipes and drains to have all needed bends and branches, and to be calked tight in all joints with lead, and the soil pipes to be held with iron hooks. All traps to be ventilated.

The wash-trays, sinks, boilers, wash-stands, and bath-tubs to have D lead waste-pipes, having S traps and brass trap-screws, and all to be well connected with the drains under cellar bottoms or with the soil-pipes in bath-rooms; and said waste pipes to be 2 inches from wash-trays, 1½ inches from kitchen sinks, and the remainder to be 1¼ inches, and those from boilers to be provided with stop-cocks.

To be safe wastes, lined with 3-pound sheet-lead, well nailed and soldered, under water-closets, wash-stands, and bath-tubs in second story, and having ¾-inch D lead waste-pipes leading to bottom of cellars. All said plumbing to be made complete.

The water-closets and wash-stands in first story to be omitted, with all their plumbing work, but all the iron drains to be put in, as shown on plans of cellars.

Gas-pipe.

Connection to be made with the gas-main at the outside of front wall of cellar, and gas-supply pipes to lead to the houses and into the same, and to have outlets for ceiling and side-lights where marked ☌ thus on the plans; all pipes above the cellars to be concealed, and to be of the needed size, and a meter connection to be made in each cellar.

Heaters.

To be a Fuller & Warren Co.'s portable hot-air furnace, located in the cellar of each house—placed in a pit excavated the needed depth—and paved with hard brick, and having 8-inch walls of hard brick, laid in cement. The furnaces to be set up complete, and to have galvanized-iron smoke-pipes connected with flues and cold-air ducts sunk below cellar bottoms in the rock, and these to be plastered inside with cement and to have 2-inch plank tops flush with cellar bottom, matched and made tight. And to be wood ducts of matched plank leading from west windows of heater cellars to the ducts under cellar bottoms, and these to have dampers or slides put in complete. To be registers located in the partitions of first and second stories where marked "R" on plans, and one in floor of each front hall, and said registers to be connected with the heaters by pipes of IX tin, made round in cellars and oval in partitions, well braced, and each pipe to have damper in cellars, and those leading to second-story rooms to have dampers 3 feet above first-story floors, having thumb-pieces and cups in the plastering. The pipes to have register-heads, and the registers to have frames, valves, and white japanned faces. To be a space of 1¼ inches tween all timbers, studs, and pipes, and all timbers opposite pipes, studs included, to be covered with tin, and all spaces in partitions opposite pipes, and around pipes where they pass through cellar ceilings, to be lathed with sheet-iron lath.

Said heaters to be guarantied to heat the houses in the coldest weather to the satisfaction of the commanding officer.

Range.

In each kitchen to be an F. & W. Co. wrought-steel oven range, 9 inches, with hot-water back set up complete, and having a Russia-iron smoke-pipe connected with flue, and an iron flue-pipe within brick flue, leading to top of chimney. A diaphragm to be in brick flue, 24 inches above floor of servants' room, and a register in wall for heating this room.

Bells.

To be an electric bell and annunciator in each house, having concealed wires, batteries and bronze buttons, the latter located at front and rear doors. Said bell to be located in kitchen. Also bronze buttons in three rooms on first and three rooms on second floor.

Speaking-tubes.

In each house to be a speaking-tube, leading from second-story front hall to kitchen. Said tubes to be concealed and to have mouth-pieces, whistles, and bronze shields.

Wires for electric lighting.

Wires for electric lighting to be put into the houses and concealed, and to run from cellar up to each gas outlet marked on the plans, including those in cellars. Main feeders to be No. 6, and laterals No. 9.

Conditions.

All work and materials to be the best quality, free from all defects, and to be put into the buildings at the proper time, so as to cause no hurtful delays, and to be protected from all damages until the houses are completed; and the entire work to be completed to the satisfaction of the commanding officer and in accordance with the drawings and specifications made by the architect, who shall decide all questions relating to their meaning.

3.—SPECIFICATIONS FOR ONE IRON FRAME RAILWAY-TRACK SCALE, FAIRBANKS'S OR EQUAL.

The railway-track scale is to be located at the Watervliet Arsenal, West Troy N. Y., at a place designated on the map. The scale is to have a capacity of 60 tons; the platform is to be 42 feet long, for a normal gauge (4 feet 8½ inches) railway track.

The contractor is to make the necessary excavations for the pit, and is to furnish all material and labor necessary for the entire completion of the work. The only material to be furnished by the Ordnance Department is building stone for the rubble masonry of the pit, but all special stone blocks and cut stone are to be furnished by the contractor, who will also provide a suitable opening in the masonry of the pit for drainage.

All masonry to be laid in best hydraulic-cement mortar, to make the pit water-tight.

A railroad track connecting with the Delaware and Hudson Canal Company tracks will be laid by the 1st of May very near the locality of the scale.

Bidders will furnish a design and full description of the work on which their bid is based.

4.—SPECIFICATIONS FOR A RAILROAD TURN-TABLE FOR THE WATERVLIET ARSENAL, WEST TROY, N. Y.

The turn-table will be located at the intersection of the center and store-house sidings, as shown on the map.

It is to have a diameter of 55 feet. The track will be of normal gauge (4 feet 8½ inches). The turn-table is to be constructed mainly of wrought-iron or steel. It is to be turned by hand-power, and two men must be capable of turning the table with a heavy locomotive on it. The turn-table must be strong enough to carry a load of 60 tons.

The contractor to make the excavations for the pit. He is to build all masonry, furnish all material, and erect the turn-table in place, in perfect working order. A suitable opening will be left in the masonry of the pit for drainage.

The Ordnance Department will furnish all stone necessary for rubble masonry, near the locality of the turn-table, but the contractor is to furnish all cut stone, the large center stone, and all other materials. A railroad track, connecting with the Delaware and Hudson Canal Company's tracks, will be laid by May 1, very near to the locality of the turn-table.

Bidders will furnish a design and full description of the turn-table and its parts, pit, etc., on which the bid is based.

NOTE.—The plans and detailed drawings referred to in the foregoing specifications can be seen at the Watervliet Arsenal, and blue-print copies thereof will be furnished to the contractor for his guidance.

PLATE II.

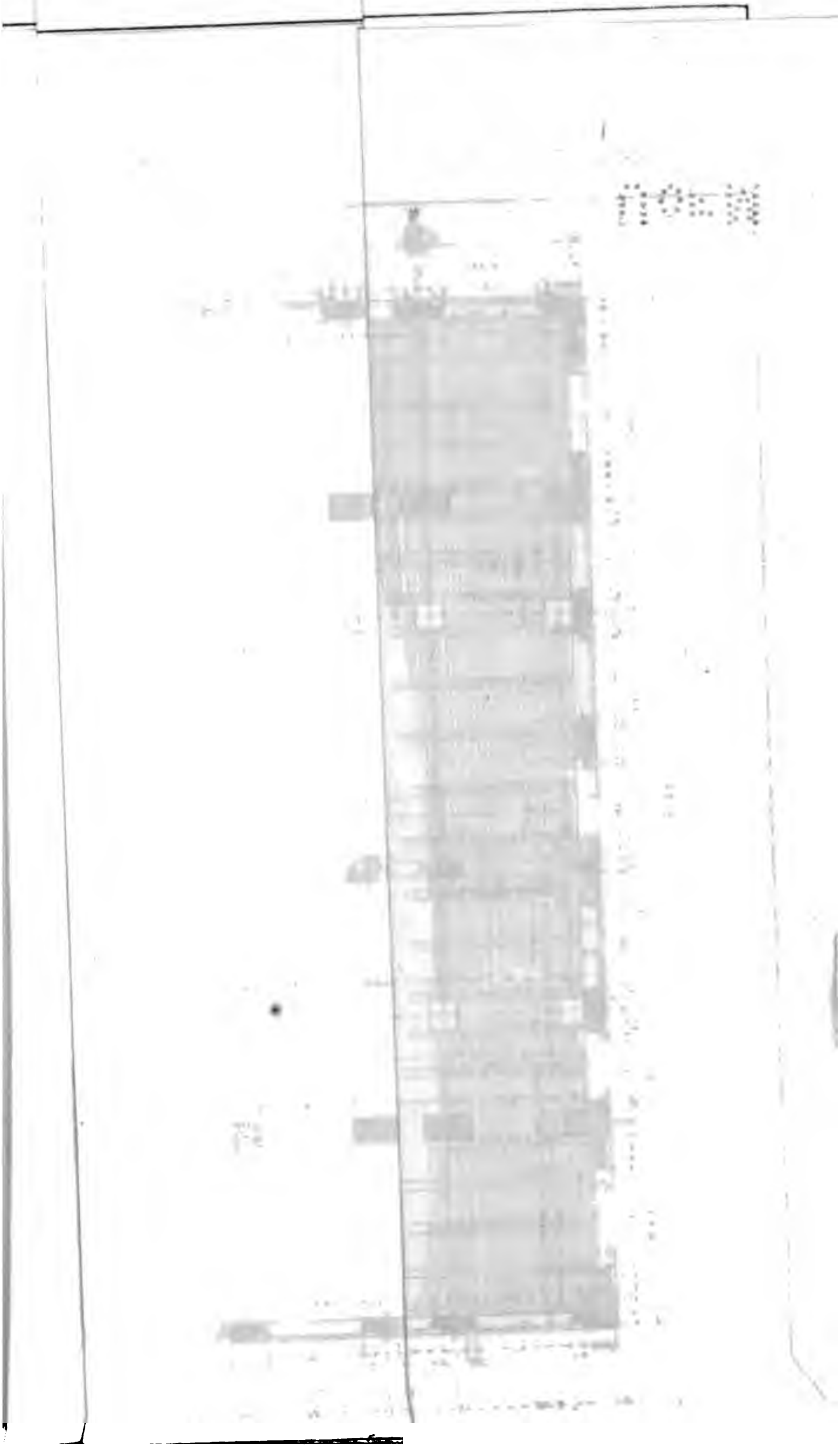
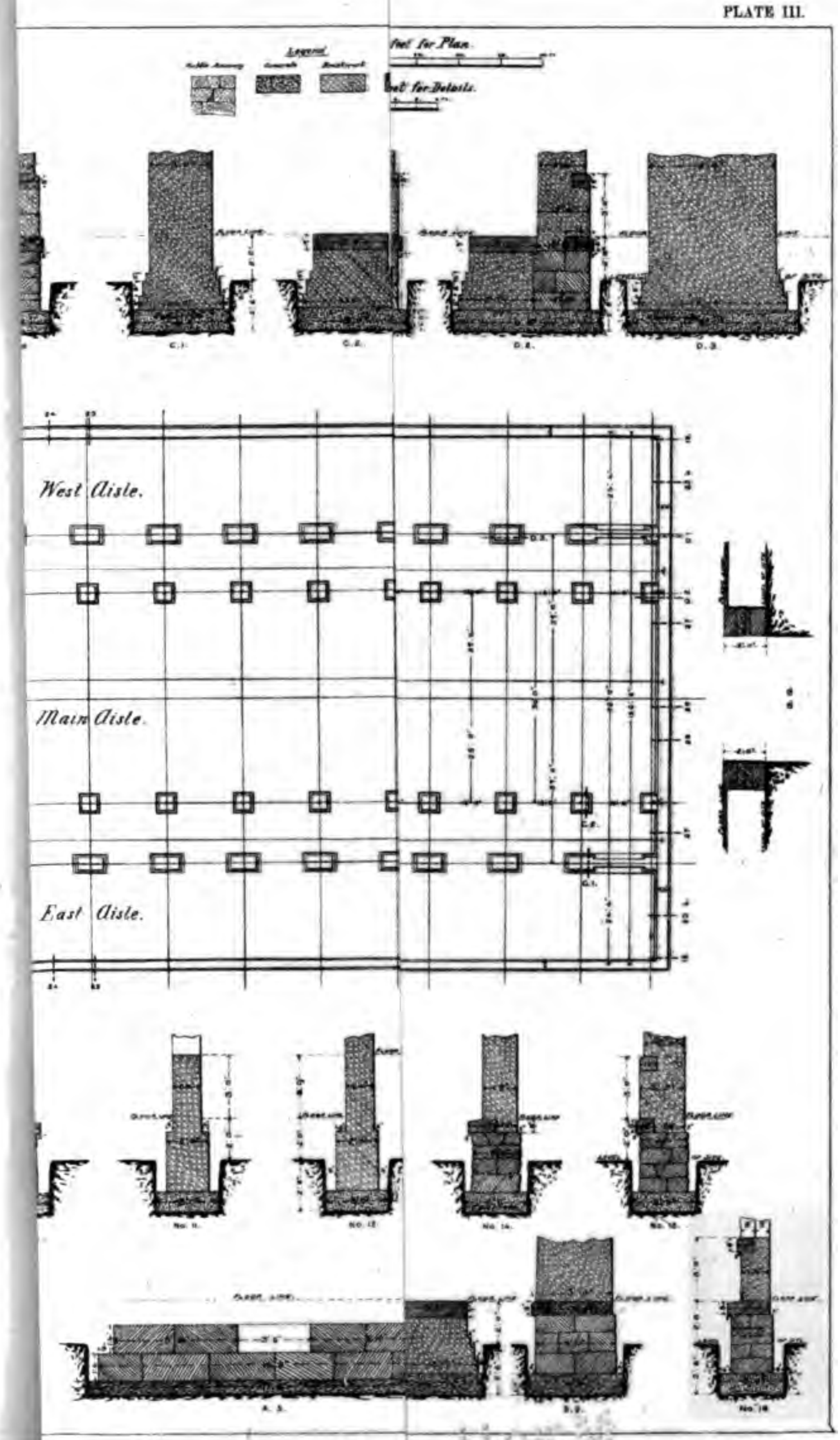


PLATE III.



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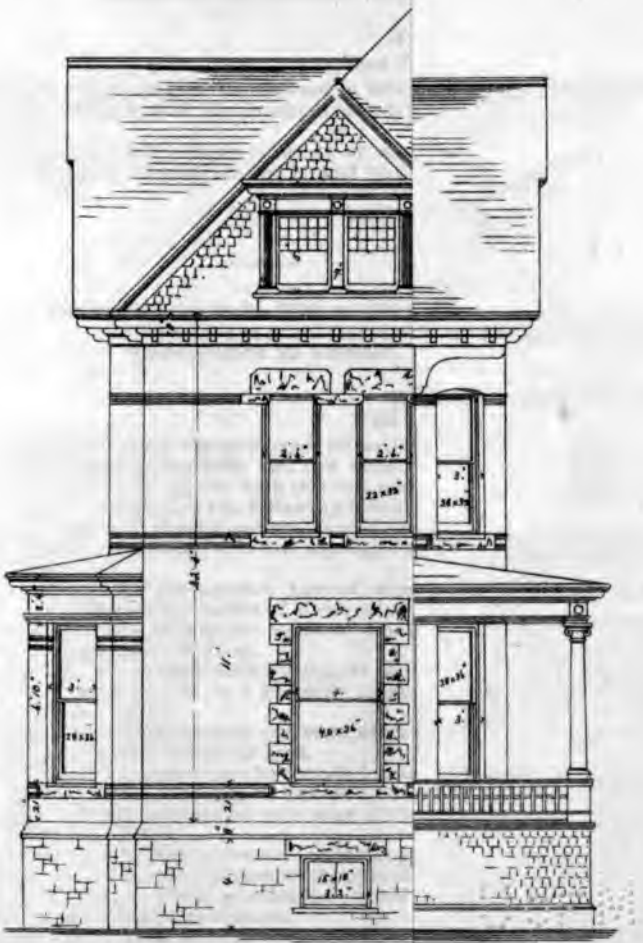
Appendix 22, 1888.

PLATE IV.



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APPENDIX 23.

MACHINE TOOLS FOR ARMY GUN FACTORY.

[Advertisement.]

PROPOSALS FOR MACHINE TOOLS.

WATERVLIET ARSENAL,
West Troy, N. Y., August 5, 1889.

Sealed proposals, in triplicate, will be received at this arsenal until 2.30 o'clock p. m. on Thursday, September 5, 1889, for machine tools required for the equipment of an army gun factory.

The Government reserves the right to reject all or any proposals or parts thereof. Specifications and all other information can be had on application to

Col. J. M. WHITTEMORE,
Ordnance Department, U. S. A., Commanding

[Read this carefully before filling out your proposal.]

INSTRUCTIONS TO BIDDERS.

WATERVLIET ARSENAL,
West Troy, N. Y., August 5, 1889.

1. This paper is published under the newspaper advertisement dated August 5, 1889.
2. Proposals must be made in *triplicate*, and this form must be used. It is further required that these proposals be signed with the full name and place of business of the bidder in the spaces provided on the following blank form.
3. Alterations by erasures or interlineations should not be made, but, if unavoidable, such change must be explained over the signature of the bidder or new blanks called for, time permitting.
4. When a firm is the bidder the member thereof who signs the firm-name to the proposal must state in addition the names of all its members.
5. Any one signing the proposals as the agent of another or others must file with it legal evidence of his authority to do so.
6. Proposals must be made in *triplicate* according to the form herewith. Each copy of the proposal will be accompanied by a guaranty in amount ***not less than one-tenth*** of the aggregate of the proposal.
7. The bidder must furnish satisfactory evidence of his ability to furnish the materials and perform the work for which he bids.
8. The bidder to whom a contract may be awarded must execute the same in quintuplicate within ten days after receiving it, and also execute a bond in ***not less than one-tenth*** the aggregate of the contract on each copy of the contract, according to the form and in the sum prescribed.
9. The bonds are to be executed by the contractor as principal and two responsible persons as sureties, under seal. Signatures of obligors and sureties must be attested by a separate witness to each when practicable. Seals to signatures on contracts and bonds must be of an adhesive substance.
10. Each of the sureties must make and subscribe to an affidavit of justification to the full amount of the bond, which must be followed by the certificate of a judge of a United States court, a United States district attorney, or other civil officer of the United States, as to the sufficiency of the individual sureties.
11. A firm will not be accepted as surety for a partner, nor a partner for a copart-

ner or firm of which he is a member, nor an officer of a corporation for such corporation.

12. In case a contractor fails to perform the stipulations of his contract in the manner and time specified, the United States may proceed against him or his sureties, or both, and charge any additional expense incurred by the United States, in the completion of the work, in excess of the contract price, to the contractor or his sureties, or both.

13. Envelopes containing proposals must be sealed and indorsed "Proposals for machine tools for army gun factory, etc.," to secure them against accidental premature opening.

14. The United States reserves the right to reject any and all bids or parts thereof.

15. As it is intended to invite the widest possible competition consistent with thorough workmanship and correct designs, the following is made a part of the general specifications for machine tools required by the Ordnance Department for the gun factory at Watervliet Arsenal, and referred to under newspaper advertisement dated August 5, 1889.

If any reliable manufacturer or bidder can show to the satisfaction of the Department that the machines upon which he bids are equal or superior to similar machines covered by these specifications, though differing therefrom in particulars which may be deemed unessential or immaterial as regards fitness for the performance of the particular work for which the said machines are intended, his bid will be received and duly considered in making the awards.

SPECIFICATIONS FOR MACHINE TOOLS.

The following specifications comprise a series of machine tools required for the equipment of the Army gun factory at the Watervliet Arsenal, West Troy, N. Y.

The machine tools are divided in classes, as follows:

Class A. 72-inch lathe for turning and boring hoops.
Class B. 60-inch lathes for turning and boring hoops.
Class C. 48-inch lathes for turning and boring hoops.
Class D. 42-inch lathes for turning and boring hoops.
Class E. Cylinder-boring machines for boring hoops.
Class F. 72-inch vertical turning and boring mill, extra heavy, for hoops.
Class F$_1$. 60-inch and 72-inch vertical turning and boring mills for hoops.
Class G. 36-inch lathes.
Class H. 26-inch lathes.
Class I. 20-inch lathes.
Class K. 24-inch slotter.
Class L. 18-inch slotter.
Class M. 26, 32, 38, and 44 inch planers.
Class N. 26-inch shaping machines.
Class O. 18-inch shaping machines.
Class P. Universal radial drilling machine.
Class R. Vertical drills, 24, 30, 36, and 50 inch.
Class S. Horizontal boring and drilling machine.
Class T. Horizontal boring, drilling, and milling machine.
Class U. Automatic gear-cutting machine, Brainard's.
Class V. Universal milling machine, heavy, Pedrick & Ayer's.
Class W. Universal grinding machines, Brown & Sharpe's.
Class X. Tool-grinding machine, Sellers'.
Class Y. Emery-wheel grinder.
Class Z. Cutter and reamer grinders, Brown & Sharpe's,
Class a. Single-frame steam-hammer.
Class b. Steel pressure-blower, Sturtevant's.

Bids will be considered for each class separately. Bidders to make two bids: one for the machine tools delivered f. o. b., Watervliet Arsenal, West Troy, N. Y., and the other bid for delivery and erection in place, ready for operation, in the new gun factory at the said arsenal. No belting is to be furnished. Bidders will furnish complete and exhaustive descriptions of their machines, accompanied by scale drawings, showing clearly all principal dimensions, and bids not accompanied by such drawings will not be considered. If desired, such drawings will be treated as confidential and returned to the bidder. Photographs may accompany such drawings, but photographs or cuts of machines only cannot be considered sufficient to permit the merits of the tools to be determined. Exception as to drawings will be made for such tools as are designated by the name of the manufacturer in the specifications.

Bidders will state time of delivery.

It is desired that the machine tools of Class "T" and Class "S" be delivered as soon as possible. All other machine tools to be delivered not before the 1st of January, 1890, nor later than the 31st of January, 1890.

Bids will be considered only for machine tools manufactured in the United States.

CLASS A.

Specifications for one 72-inch lathe for boring and turning hoops.

The lathe is to swing 72 inches over the ways and not less than 48 inches over the carriage. Distance between centers to be 8 feet.

Driving-cone to have five steps for 5-inch belt, ranging approximately from 15 to 27 inches diameter.

Lathe to be triple-geared, giving fifteen changes of speed.

No pinion to have less than 22 teeth, and *back gear* to be double and about of the following proportions:

Cone-pinion, 24 teeth .... Back gear, 84 teeth	1-inch pitch, 2¾-inch face ..	Slow train.
Back-gear pinion, 22 teeth .. Main driving-gear, 66 teeth .	1¼-inch pitch, 4-inch face ..	
Cone-pinion, 50 teeth .... Back gear, 60 teeth	1-inch pitch, 2¾-inch face ..	Fast train.
Back.gear pinion, 22 teeth .. Main driving-gear, 66 teeth.	1¼-inch pitch, 4-inch face ..	

Pitch of gears to be not less than given in this schedule.

Back gear to be so arranged on shaft as to be made movable by screw along the shaft and clamped in position.

Cone-shaft to be geared into face-plate about as follows:

Face-plate gear, 120 teeth, 1¼-inch pitch, 5-inch face.

Face-plate pinion to be of steel, 20 teeth, 1¼ inch pitch, 5-inch face.

All pinions of less than 30 teeth must be made of sound steel casting or forging, all other gear of strong, close-grained cast-iron, having 25 per cent. of cold-blast iron. All gearing must be accurately cut.

Main driving spindle to be of hard, close-grained cast-iron, with front-bearing 11 to 12 inches in diameter by 16 inches long, back gearing 7 to 8 inches diameter by 12 inches long; mixture to contain 25 per cent. of cold-blast iron.

Spindle to be fitted with steel bush in the front end to take the center, and with flange to bolt to face-plate. Length of spindle in bearing to be about 4 feet 9 inches.

Face-plate to be furnished with slots for clamping work, and fitted with four steel chuck-jaws, set up by string screws so arranged as to clamp from the outside or the inside of hoops. Chuck-jaws must be finished to one diameter in place and hardened. Face-plate gear to be made a separate casting and bolted to face-plate. Spindle-bearings to be made in halves and capped to strong flanges on the ends, and to be made of close-grained hard iron, as specified for spindle.

Centers to be made of steel, hardened, and at least 3½ inches in diameter, with points made to inclose an angle of 60 degrees.

Feeds.—All feeds to be arranged for steel. Feeds to be positive, driven by compound gearing, and ranging from $\frac{1}{40}$-inch for the finest to about ⅜-inch for the coarsest. Reversing-geer for feed to be placed at the end of the head-stock, and change-gears for screw-cutting are to be provided to cut threads varying by ⅛-inch and $\frac{1}{16}$-inch, and for the finest pitches of $\frac{1}{20}$-inch and $\frac{1}{16}$-inch and coarsest of 1 inch.

Lead screw to be of steel, 3-inches in diameter, ½-inch pitch, and splined to drive rack-feed for turning. Lead-screw nut must surround the screw entirely, and be operated by a cam, and not less than 10 inches long.

Feed-rack, for carriage feed, to be not less than 3-inch face and 1⅛-inch pitch. To be of steel.

Apron-gears must be easily accessible for oiling.

Carriage to be at least 5½ feet long, and fitted to ways on the front and back of bed, and also bearing on the inner way used for the tail-stock guide. Fitted with one heavy compound rest.

Compound rest to have base not less than 20 inches wide by 30 inches long. To be provided with powerful cross-feed, enabling rest to feed across entire width of face-plate. Upper slide of compound rest to be provided with hand and power feed.

Wing-rest to be placed on front wing of carriage for turning work the full swing of lathe.

Bed to be not less than 5 feet 4 inches in width over the top. To be fitted with three large ways, two for the carriage and the third one to guide head and tail stocks.

Bed must be so extended to the front that the line of strain when turning the full diameter of swing will fall inside the front way of bed. Cross-girts to be box-girder form and not over 28 inches between centers. Depth of bed to be not less than 24 inches.

Tail stock to have bearing on bed not less than 38 inches long by 42 inches wide. Tail-stock top to be arranged with convenient set-over and held down by four strong bolts, and in addition to have strong pawl dropping into ratchet on bed, giving a positive resistance to thrust. Tail-stock spindle to be of steel forging 6¼ inches diameter. Top of tail-stock to be capped or otherwise arranged that tail-spindle can be removed and boring-bar put in its place. Tail-stock to be provided with four rollers arranged to lift tail-stock slightly off the bed and enable its easy and rapid moving on the bed.

Steady-rest.—To hold the outer ends of hoops while being bored, a strong steady-rest, of approved design, must be provided. Rest to have removable top and fitted with five steel jaws, adjustable by screws from behind, and faced with brass facings on the inner ends. Section of jaws to be not less than 5 by 2½ inches. Three jaws to be placed in lower half of rest and two in upper half. Jaws to be accurately fitted to rest, and to be adjustable for diameters from 48 to 40 inches. Inner diameter of rest to be bored out for the reception of reducing-rings. Steady-rest to have bearing on bed not less than 18 inches long.

The material and workmanship must be first class throughout. All gearing must be accurately cut. All shafts and feed-screws to be of steel, and all bolts of steel or refined iron, and all nuts frequently used shall be case-hardened.

All necessary counter-shafts, pulleys, wrenches, and other appliances to complete lathe ready for operation must be furnished.

Speed of counter-shaft to be such as to give cutting speeds of from 12 to 20 feet per minute.

Taper attachment.—To turn the taper on the outside of hoops, a taper attachment of extra strength and great accuracy must be provided. This attachment must give tapers up to 1 inch to the foot in the diameter of the piece turned, and must be adjustable on the bed, and of length to turn a continuous taper 4 feet long.

CLASS B.

Specifications for threc 60-inch lathes for turning and boring hoops.

The lathe is to swing 60 inches over the ways and 48 inches over the carriage. One lathe is to take 15 feet, one 12 feet, and one 10 feet between centers.

Driving cone to have six steps for 4½-inch belt, diameter of smallest step to be not less than 22 inches.

Cone to be strongly back-geared, with pinion driving into gear on face-plate, giving 12 changes of speed.

Back gear to be approximately of the following proportions:

Cone-pinion, 25 teeth	¾-inch pitch, 3-inch face.
Back gear, 88 teeth	
Back gear pinion, 20 teeth	1-inch pitch, 4-inch face.
Cone-spur-gear, 70 teeth	
Face-plate gear, 100 teeth	1¼-inch pitch, 5-inch face.
Face-plate pinion, 17 teeth	

Spindle to be made of close-grained hard cast-iron, containing at least 25 per cent of cold-blast iron. Front bearing from 9 to 10 inches diameter by 14 inches long, back bearing from 6 to 7 inches diameter by 10 inches long. Spindle to be driven into face-plate and provided with steel bush for center. Length of spindle in bearings to be not less than 48 inches.

Spindle-bearings to be made in halves and capped. To have heavy flanges on the ends, and made of hard, close-grained cast-iron, same as specified for spindle.

Face-plate to be driven on and bolted to the spindle. To be 60 inches diameter. To have slots for clamping work, and provided with four adjustable steel jaws of large proportions, arranged to be set up by set-screws from the back. Chuck-jaws, to be arranged to be used either on the inner or outer side of hoops. They are to be turned to one diameter in place and hardened. Face-plate gear to be made a separate casting and bolted to face-plate.

Centers to be made of steel, 2⅞ inches diameter, hardened, and pointed to inclose an angle of 60 degrees.

Feeds to be positive, driven by compound-gearing from head-stock. Feed-gears to give range of feed from $\frac{1}{40}$ inch for the finest to ⅜ inch for the coarsest.

Change-gears for screw cutting must be provided for changing pitches by $\frac{1}{16}$ and ⅛ inch, and for cutting screw threads ranging from $\frac{1}{20}$ to $\frac{1}{16}$ inch for the finest to 1 inch *for the coarsest.*

Material for gearing.—All pinions of less than 30 teeth to be made of sound steel casting or forging. All other gears to be of close-grained cast-iron containing 25 per cent. of cold blast iron. All gearing throughout to be accurately cut.

Lead-screws to be of steel 2⅝ inches diameter and ½ inch pitch; to be fitted with lead-screw nut, operated by cam, and not less than 9 inches long.

Feed-rack for carriage-feed to be not less than 2½ inches face and ¾-inch pitch. To be of steel.

Apron-gears and bearings for same must be easily accessible for oiling, and apron arranged with reversing gear for the carriage feed.

Carriage to be 5 feet long, and fitted to ways in the front and back of bed, and bearing on the inner way used for the tail-stock guide. Carriage to be fitted with one heavy compound tool-rest.

Compound-rest to have base not less than 15 inches wide by 20 inches long. To be provided with power cross-feed for heavy work. Power feed to be provided for the upper slide of rest.

Wing-rest to be placed on front wing of carriage for turning work the full swing of lathe.

Bed to be not less than 48 inches wide and fitted with three ways, two for the carriage and one to guide the tail-stock. Bed must be well extended to the front to give support to the carriage, so that the line of strain, when turning the full diameter of swing, will fall inside the front way of bed. Cross-girts must be of box-girder form and 24 inches between centers. Depth of bed to be not less than 20 inches.

Tail-stock to have a bearing on the bed 30 inches long by about 32 inches wide. Tail-stock to be provided with convenient set-over and held down by four strong bolts. In addition, tail-stock base is to be provided with a strong pawl, dropping into ratchet in bed, giving a positive resistance to thrust. Tail-spindle to be of steel, 6½ inches diameter. Top of tail-stock to be capped, or otherwise arranged so that tail-spindle can be removed and boring-bar put in its place. Tail-stock to be provided with four rollers, arranged to lift tail-stock slightly off the bed and enable easy and rapid movement along the bed.

Steady-rest.—To hold the outer ends of hoops while being bored, a strong steady-rest, of approved design, must be provided. Rest to have removable top and to be fitted with five steel jaws, adjustable by screws, and faced with brass facings on the inner ends. Section of jaws to be not less than 4½ by 2½ inches. Three jaws are to be placed in the lower half and two in the upper half of steady-rest, and accurately fitted in their pockets. Steady-rest bearing on bed to be not less than 15 inches long, and opening in rest to take in 40 inches, and to be bored out in position for the reception of reducing-rings. Jaws to be adjustable for diameters from 40 to 34 inches.

All necessary counter-shafts, pulleys, wrenches, and other equipments to complete lathe ready for running must be furnished.

Counter-shafts' speed to be arranged for a cutting speed of from 12 to 20 feet per minute.

The material and workmanship of these lathes must be first class throughout. All shafts and feed-screws must be of steel, and all bolts of steel or refined iron. All nuts frequently used must be case-hardened.

Taper-attachment.—To turn the taper on the outside of hoops a taper-attachment of extra strength and great accuracy must be provided. This attachment must give a range of tapers from 0 to 1 inch to the foot in the diameter of piece turned, and must be adjustable along the bed, and of length sufficient to turn a continuous taper 4 feet long.

CLASS C.

Specifications for two 48-inch lathes for boring and turning hoops.

The lathe is to swing 48 inches over the ways and 36 inches over the carriage, and to take 10 feet between centers.

Driving-cone to have six steps for 4½ inch belt, diameter of smallest step to be not less than 8 inches.

Cone to be strongly back-geared, with pinion on cone-shaft driving into gear on face-plate, giving 12 changes of speed.

Back gear to be about of the following proportions:

Cone-pinion, 26 teeth, ¾-inch pitch	3-inch face.
Back-gear, 90 teeth, ¾-inch pitch	
Back-gear pinion, 20 teeth, 1-inch pitch....	4-inch face.
Cone-spur gear, 70 teeth, 1-inch pitch....	
Face-plate gear, 100 teeth, 1-⅜inch pitch ...	5-inch face.
Face-plate pinion, 17 teeth, 1⅜-inch pitch...	

Spindle—To be of forged-steel, containing at least 0.5 per cent. of carbon, with clean surfaces in bearings. Front bearing to be not less than 7 inches diameter by 10 inches long. Back bearing 4½ to 5 inches diameter by 8 inches long. Spindle to drive into face-plate and to be provided with flange to bolt to same. Length of spindle in bearings to be not less than 48 inches.

Face plate to have 48 inches diameter, to be provided with slots for clamping work, and fitted with four steel chuck-jaws, set up by strong screws, so arranged as to chuck from the inside or outside of hoops. Chuck-jaws must be finished to one diameter in place and hardened. Face-plate gear to be made a separate casting, and bolted to face-plate.

Spindle-bearings to be made of hard composition metal containing 85 per cent. copper and 15 per cent. tin. To be provided with strong flanges on the ends, made in halves and capped. Bearings must be carefully scraped to fit spindle.

Centers to be of tool-steel, 3 inches diameter, hardened, with points made to include an angle of 60 degrees.

Feeds to be suitable for steel. All feeds to be positive, driven by compound-gearing, and ranging from $\frac{1}{40}$ inch for the finest to ¼ inch for the coarsest. Reversing-gear for the feed to be placed in the end of head-stock, and change-gears for screw-cutting to be provided to cut screw-threads varying by ⅛ and $\frac{1}{10}$ inch, and for finest pitches of $\frac{1}{20}$ and $\frac{1}{16}$ inch to the coarsest of 1 inch.

Material for gearing all driving-pinions having less than 30 teeth to be made of sound steel-castings or forgings, and all other gears to be made of strong close-grained cast-iron having at least 25 per cent. of cold-blast iron. All gearing of any kind to be accurately cut.

Lead-screw to be of steel, 3 inches diameter, ½-inch pitch, and splined to drive rack-feed for turning. Lead-screw nut to be operated by cam, and to be not less than 8 inches long.

Feed-rack for carriage-feed to be not less than 2½-inch face and ¾-inch pitch, and to be made of steel.

Apron-gears and bearings for same must be easily accessible for oiling.

Carriage to be 60 inches long, and fitted to ways on the front and back of bed, and bearing on the inner way used for the tail-stock guide. Carriage to be fitted with one heavy compound-rest.

Compound-rest to have base not less than 15 inches wide by 22 inches long. To be provided with powerful cross-feed designed for heavy work. Upper slide of compound-rest to be provided with power-feed.

Wing-rest to be placed on front wing of carriage for turning work the full swing of lathe.

Bed to be not less than 42 inches wide, to be fitted with four ways, two for the carriage and two for the head and tail-stocks. Bed must be well extended to the front to bring line of strain inside of carriage-way. Cross-girts to be of box-girder form, 24 inches between centers. Depth of bed to be not less than 18 inches.

Tail-stock to have bearing on bed 28 inches long by 28 inches wide. Top of tail-stock to be provided with convenient set-over, and held down by four strong bolts, and in addition tail-stock is to be provided with a strong pawl dropping into ratchet in bed, giving a positive resistance to thrust.

Tail-spindle to be of forged-steel 5½ inches diameter.

Top of tail-stock to be capped or otherwise arranged so that tail-spindle can be removed and boring-bar put into its place.

Tail-stock is to be provided with suitable mechanism for moving it easily along the ways.

Steady-rest.—To hold the outer ends of the hoops while being bored, a strong, steady-rest of approved design must be provided. Rest to have removable top and to be fitted with five steel jaws, adjustable by screws, and faced with brass facings on the inner ends. Section of jaws to be not less than 3½ by 2 inches. Three jaws to be placed in the lower half of rest and two in the upper half. Jaws to be accurately fitted to rest. Opening of rest to be bored in place on the lathe for the reception of reducing-rings. Opening to take 36 inches diameter and jaws to be adjustable for diameters from 36 to 30 inches. Steady-rest to have a bearing on bed not less than 12 inches long.

All counter-shafts, pulleys, wrenches, and other equipment necessary to complete the lathe ready for operation must be provided. Speed of counter-shafts to be suitable for a cutting speed of from 12 to 20 feet per minute. The material and workmanship must be first-class throughout. All shafts and feed-screws must be made of steel, and all bolts of steel or refined iron. All nuts frequently used to be case-hardened.

Taper attachment.—To turn the taper on the outside of hoops, a taper attachment of extra strength and great accuracy must be provided. Attachments must give tapers ranging from 0 to 1 inch per foot length. It must be made adjustable lengthwise on the bed, and of length sufficient to turn a continuous taper 4 feet long.

CLASS D.

Specifications for two 42-inch lathes for turning and boring hoops.

Lathe to swing 42 inches over the ways and 32 inches over carriage, and to take 10 feet between centers.

Driving-cone to turn on spindle, to have five steps 4-inch belt; smallest step to be not less than 8 inches in diameter.

Cone to be triple-geared to face-plate, giving 15 changes of speed. Gearing to be approximately as follows:

Cone-pinion, 30 teeth, ⅝-inch pitch.....	2½-inch face.
Back gear, 135 teeth, ⅝-inch pitch......	
Back-pinion, 45 teeth, ¾-inch pitch......	3-inch face.
Cone-spur, 90 teeth, ¾-inch pitch......	
Face-plate gear, 90 teeth, 1-inch pitch.	3½-inch face.
Face-plate pinion, 15 teeth, 1-inch pitch.	

Spindle to be of open-hearth steel, containing not less than one-half per cent. of carbon, with clean surfaces in the bearings. Front bearing to be 5½ inches diameter by not less than 7 inches long. Back bearing 3½ inches diameter by 6 inches long. Spindle to be forced on the face-plate and securely keyed. Length of spindle in bearings to be not less than 42 inches.

Face-plate to have diameter of 42 inches, to be provided with slots for clamping work and fitted with four steel chuck-jaws, set up by strong screws, and so arranged as to chuck from the inside or outside of hoops.

Chuck-jaws must be finished to one diameter in place, and hardened. Face-plate gear to be made a separate casting and bolted to face-plate.

Spindle bearings to be made of hard composition metal containing 85 per cent. copper and 15 per cent. tin. To be provided with strong flanges on the ends. Bearings must be carefully scraped to fit spindle.

Centers to be of tool-steel 2½ inches diameter, hardened, with points made to inclose an angle of 60 degrees.

Feeds to be arranged for steel, to be positive, driven by compound gearing, and ranging from 1/40 inch for the finest to ¼ inch for the coarsest. Reversing-gear for feed to be placed in the end of head-stock, and change-gears for screw cutting to be provided to cut screw-threads varying by ⅛ and 1/10 inch, and for finest pitches of 1/20 and 1/16 inch to the coarsest of 1 inch.

Material for gearing all driving-pinions of less than 30 teeth must be made of sound steel castings or forgings, and all other gears must be made of strong close-grained cast-iron containing 25 per cent. of cold-blast iron.

All gearing of whatever kind must be accurately cut.

Lead screw to be of steel 2⅝ inches in diameter, ½-inch pitch. Lead-screw nut to be operated by cam and to have length of not less than 8 inches.

Feed-rack for carriage-feed to be not less than 2½-inch face and ¾-inch pitch, and to be of steel.

Apron-gears and bearings for same must be easily accessible for oiling.

Carriage to be not less than 50 inches long, and fitted to ways on front and on back of bed, and bear on the inner way used for the tail-stock guide. Carriage to be fitted with one heavy compound rest.

Compound rest to have base not less than 10 inches wide by 18 inches long. To be provided with powerful cross.feed, designed for heavy work.

Wing rest to be placed on front wing of carriage for turning work the full swing of lathe.

Bed to be not less than 33 inches in width. To be fitted with four ways, two for the carriage and two for the head and tail stocks. Bed must be well extended to the front to bring line of strain inside the outer carriage-way. Cross-girts to be of box-girder form and to be not over 24 inches between centers. Depth of bed to be not less than 16 inches; if possible, greater.

Tail-stock to have bearing on bed not less than 24 inches long by 22 inches wide. Tail-stock tops to be provided with set-over, and held down by four strong bolts. In addition, tail-stock to have strong pawl dropping into ratchet in bed, giving a positive resistance to thrust. Tail-stock spindle to be of steel forging, 4½ inches in diameter. Top of tail-stock to be capped or otherwise arranged so that tail-spindle can be removed and boring-bar put into its place.

Steady-rest.—To hold the outer ends of hoops while being bored, a strong steady-rest of approved design must be provided. Rest to have removable top and fitted with four steel jaws adjustable by screws, and faced with brass facings on the inner ends. Section of jaws to be not less than 3½ by 1¾ inches. Two jaws to be placed in lower and two in upper half of rest. Steady-rest to have bearing on bed not less than 10 inches long and opening to take 27 inches. Opening to be bored out in place for the reception of reducing-rings. Jaws to take in diameters from 32 to 28 inches.

All necessary counter-shafts, pulleys, wrenches, and other appliances to make the lathe complete and ready for operation must be provided. Speed of counter-shaft to be suitable for steel.

The material and workmanship must be first class throughout. All shafts and feed-screws must be of steel, and all bolts of steel or refined iron. All nuts frequently used are to be case-hardened.

Taper attachment.—To turn the taper on the outside of hoops, a taper attachment of extra strength and great accuracy must be provided. Attachment must give range of tapers from 0 to 1 inch to the foot, and must be adjustable lengthwise on the bed and of sufficient length to turn a continuous taper of 4 feet length.

CLASS E.

Specifications for two cylinder boring machines.

This machine will be used for boring hoops ranging in diameter from 11⅜ inches to 22¾ inches, and in length from 19¼ to 35 inches. Largest outside diameter of hoop 30¾ inches.

Machine to consist of bed upon which are mounted the driving-head and carriage. Distance from center of boring bar to top of carriage to be 20 inches.

Driving-gear.—Bar to be driven by tangent gearing, transmitting motion from 4-step cone, for 4-inch belt, ranging from 18 to 22 inches diameter. Worm-wheel to be approximately 30 inches pitch diameter, and cone geared to bar in ratio of not less than 30 to 1. End-thrust of worm to be taken up by anti-friction washers.

Head-stock to be bolted to end of bed, to be about 28 inches long, and carry on its outer end the worm-gear casing. Head-stock to be fitted with sleeve driving the bar from the worm-gear. Bearing for sleeve to be capped. Sleeve to run in composition bearings of 90 parts copper and 10 parts tin, to be in halves and at least 10 inches long. Worm, worm-wheel, anti-friction washes, and driving-sleeve to be made of strong close-grained iron containing 25 per cent. of cold-blast iron.

Boring-bar to be of open-hearth steel, containing ¼ per cent. carbon. To be 7¾ inches diameter, and provided with two splines on opposite sides for driving-bar, ¾ inch wide, ⅛ inch deep. Driving-feathers to be firmly fastened in the sleeve which drives bar, and to be not less than 8 inches long.

Back-head to be of same length as head-stock (28 inches), and bolted to bed at the opposite end from driving-head, leaving a clear space of 48 inches between the heads. To be provided with a cast-iron sleeve flanged at each end, made of close-grained iron, and feathered to bar to revolve with it. Sleeve to run in composition bearings composed of 90 parts copper and 10 parts tin; bearings to be in halves and at least 10 inches long. Back-head to be capped, and to be in absolute alignment with driving-head.

Feed-bar to be fed by rack and pinion, both of steel, ⅝-inch pitch, 3-inch face. Pinion to have not less than 15 teeth. Feed-rack to be attached to outer end of bar, and well provided with anti-friction washers to take up thrust.

Four changes of feed provided for, ranging from $\frac{1}{16}$ inch to ¼ inch, and reversible in either direction. Bar to feed 40 inches at one setting, and feed-rack to be arranged to allow bar being drawn by hand across the opening between the two heads. Feed-mechanism and guide for feed-rack to be attached to back-head.

Carriage to be 36 inches long, movable on the bed, and provided with bolts for bolting to bed. Upper surface to be well provided with slots to receive two steady-rests.

Steady-rests to be two in number, with removable top. Lower half to be arranged to bolt to carriage, and provided with two adjustable bearings for holding hoops ranging from 31 inches to 13 inches diameter. Steady-rest top to clamp hoops and have bearing on hoops in at least two places.

Bed to be approximately 9 feet long by 3 feet wide and not less than 16 inches deep, with top provided with T-slots for holding carriage. Sides of bed to be joined by double-webbed girders about 24 inches between centers. Top and bottom flanges to be not less than 6 inches wide, and metal in sides 1¼ inches thick.

Boring heads.—Boring-heads, to clamp to bar and to be provided with driving-feathers and fitted with four adjustable tools each, must be provided to bore out or enlarge the following rough diameters, viz: 11⅜, 11⅝, 12⅛, 12⅝, 13⅛, 13¾, 14, 14¼, 14⅝, 15⅛, 15⅞, 16⅜, 16⅞, 17¼, 17⅜, 17¾, 18¼, 19, 19⅝, 20¾, 21¼, 21⅝, 22¾.

Hubs of boring-heads to be not less than 10 inches long.

Workmanship and material to be first class throughout. All shafts not otherwise specified to be of good machinery steel, all bolts to be of steel or refined iron, and all nuts frequently used to be case-hardened.

Counter-shafts, pulleys, hangers, wrenches, and all other appliances to complete machine ready for operation to be furnished with machine. Accuracy of machine must be guarantied.

CLASS F.

Specifications for one 72-inch vertical boring mill (extra heavy), for boring and turning hoops 42 inches deep, to turn 73 inches diameter and 48 inches high under tool-holders.

This machine to consist of bed not less than 20 inches deep, with table supported on circular bearing near outer circumference. Table to be driven on and bolted to a long spindle with split conical sleeve at upper end and step-bearing at lower end.

Housings to be of box form, with heavy front post at least 8 inches on the face. Housings to be bolted to bed by six bolts 1¾ inches diameter, and to reach down the full depth of bed. Top of housings to be joined by a top brace at least 22 inches deep.

Cross rail to be of box form, with arched back, completely closed. Depth of housing on face to be not less than 23 inches. Depth from face to back in center to be not less than 18 inches.

Cross-rail to be fitted to front of housings and accurately scraped to give full and perfect bearing on housing-faces.

Boring-heads.—Two boring-heads, each fitted with independent cross-feed screw, to be accurately fitted to cross-rail. Each head to consist of saddle 26 inches wide. Swing arranged for set-over for turning tapers. Set-over to be operated and controlled by worm-gearing on the upper circular arc of saddle. Length of swing to be not less than 48 inches and to have capped bearing at upper and lower ends for boring-bar.

Boring-bars to be of open-hearth steel, containing ½ per cent. of carbon, to be octagon in section; section to be equal to area of 8½-inch circle. Lower ends of bars to be fitted with removable tool-holders of forged steel, so arranged that tools can be set in vertical or horizontal position on either side of bar. Vertical travel of bars to be 45 inches.

Feeds.—Each head to be provided with cross-feed for saddle and vertical feed for bar. Feeds to be reversible and independent for each head.

Right-hand head to be fitted with opening-nut on feed-screw, and provided with rack pinion for rapid movement on the cross-rail.

Feed to be driven by friction-disk and quickly adjustable to any degree from $\frac{1}{16}$ inch to ½ inch.

Counterweight.—Bars to be counterbalanced by one weight common to both bars. Chain and sheaves for counterweight to be arranged to always pull in a direct parallel to the axis of bar.

Table to have diameter of 70 inches, and to be not less than 5 inches deep on outer rim.

To be provided with T-slots for holding work, and, in addition, to have four steel chuck-jaws, adjustable to any diameter, and arranged for inside or outside chucking, and to be readily removable, leaving the table clear for other work.

Spindle to be 11 inches diameter at upper end, with upper bearing not less than 11 by 16 inches long, fitted in split conical bush for taking up wear. Lower spindle-bearing to be not less than 6 inches diameter by 10 inches long. Length of spindle under table to be not less than 50 inches. Spindle and bushes to be made of strong, close-grained cast-iron, containing 25 per cent. of cold-blast iron. Lower spindle-step to be provided with wedge for raising table off the outer bearing.

Driving-gear table is to be driven by cone-pulley placed in the left-hand side of bed and transmitting motion to table by means of horizontal shaft, bevel-gears, vertical shaft, and circular gear and pinion under table.

Table rack-gear to have about 120 teeth and not less than 1¾ inches pitch and 6 inches face. To be accurately cut from the solid. Gear to be bolted to the bottom of table.

Driving-pinion to be of forged steel and to have not less than 20 teeth, 1¾ inches pitch, and 6 inches face.

Driving-cone to have six steps for 4-inch belt, ranging about from 12 to 26 inches diameter.

Cone to be back-geared approximately as follows:

Cone-pinion, 25 teeth ..... } ¾ P.
Back-gear, 100 teeth ...... }
Back-gear pinion, 20 teeth. } 1 P.
Cone-spur, 80 teeth .... }

Bevel-gears to have about 25 and 35 teeth, respectively, and not less than 1¾ inches pitch and 5 inches face, giving 12 changes of speed.

Ratio of cone to table to be about 130 revolutions of cone to 1 revolution of table.

Material.—Driving-shafts to be of open-hearth steel containing ½ per cent. of carbon. Shafts to run in bronze bushes containing 90 per cent. of copper and 10 per cent. tin. All other shafts and all feed-screws to be of good machinery steel. All bolts to be of refined iron, and all nuts frequently used to be case-hardened.

Gearing.—All the gearing to be made of strong close-grained iron containing not less than 25 per cent. of cold-blast iron, unless otherwise specified. All pinions having less than 30 teeth to be of steel.

Workmanship and material to be first class throughout.

All working parts to be accurately fitted and all bearing surfaces to be accurately scraped to perfect bearings.

All counter-shafts, hangers, pulleys, wrenches, and other appliances to complete machine ready for operation are to be furnished with mill. Foundation plans to be furnished.

CLASS F₁.

Specifications for six 60-inch and one 72-inch vertical boring mills.—General description.

Machine to consist of bed not less than 20 inches deep, with table supported on circular bearing near outer circumference. Table to be driven on, and bolted to long spindle with split conical sleeve at upper end and step-bearing at lower end.

Housings to be of box (double-web) form, bolted to side of bed by four heavy bolts, and reaching down the full depth of bed. Top of housings to be joined by a top brace at least 22 inches deep.

Cross-rail to be fitted to front of housings, and accurately scraped to give full and perfect bearing on face of housings. Depth of cross-rail to be not less than 21 inches.

Boring-heads.—Two boring heads, each fitted with independent cross-feed screw, to be accurately fitted to cross-rail. Each head to consist of a saddle 24 inches wide, swing arranged for set-over for turning and boring tapers. Set-over to be operated and controlled by worm-gearing on the upper circular arc of saddle. Length of swing to be not less than 40 inches and to have capped bearing at upper and lower ends for boring-bar.

Boring-bar to be of open-hearth steel containing at least ½ per cent. of carbon, and equal in section to 6¼ inches diameter. Lower end of bar to be fitted with removable tool-holder, so arranged that tool can be set in vertical or horizontal position on either side of bar. Vertical travel of bars to be 36 inches.

Feed.—Each head to be provided with cross-feed for saddle and vertical feed for bar. Feeds to be reversible and independent for each head. Right-hand head to be fitted with opening nut on feed-screw, and provided with rack-pinion for rapid movement on the cross-rail. Feed to be driven by friction-disc, quickly adjustable to any degree from $\frac{1}{40}$ inch to ¼ inch.

Counter-weight.—Bars to be counter-weighted by one counter-weight common to both bars. Chain and sheaves for counter-weight to be so arranged as to always pull in a direction parallel to the axis of bar.

Driving-gear to consist of driving-cone strongly back-geared, and driving into a steel spur-pinion on vertical shaft under table. Said steel pinion to engage with an accurately cut circular rack bolted to the lower side of table.

Material of driving-gear.—All driving-pinions of less than 30 teeth are to be made of steel forging or casting, and all larger gears to be of strong, close iron, containing at least 25 per cent. of cold-blast iron.

Table-spindle and bearings to be made of same material as specified for the larger gears.

Driving-shafts.—All the driving-shafts transmitting motion from the driving-cone to the table-rack are to be made of open-hearth steel containing at least ½ per cent. carbon, and bearings for these shafts, as well as for all other shafts running at high speed, are to be provided with brass bushings, said bushings to be of hard bronze, containing 85 per cent. of copper and 15 per cent. of tin.

Cross-rail to be raised and lowered by reversible elevating-gear, conveniently operated from the side of mill.

Lower spindle-step to be provided with wedge for raising the table of the circular bearing when boring holes of small diameter.

Material and workmanship to be first-class throughout. All shafts and feed-screws not otherwise specified are to be made of steel, and all bolts to be of steel or refined iron. All nuts frequently used to be case-hardened.

All counter-shafts, hangers, pulleys, wrenches, and other appliances to complete machine ready for operation are to be furnished with mills. Mills to be erected by manufacturer on foundations prepared by the Ordnance Department.

60-inch vertical boring-mill.

To have a clear swing of 61 inches, and take work under the tool 42 inches high.

Driving-cone to have five steps for 4-inch belt, ranging from 8 inches to 20 inches diameter. Cone to be strongly back-geared, approximately in following proportions:

Cone-pinion, 30 teeth, ¾-inch pitch.
Back-gear spur, 75 teeth, ¾-inch pitch.

Back-gear pinion, 16 teeth, 1-inch pitch.	
Cone-spur, 64 teeth, 1-inch pitch.	
Table-rack pinion (steel), 16 teeth, 1⅝-inch pitch...	5-inch face.
Table-rack, 102 teeth, 1⅝-inch pitch	

Giving ten changes of speed.

Table to have diameter of 60 inches, and to be 4½ inches deep on outer rim. To be provided with T-slots for holding work, and in addition to have four steel chuck-jaws, adjustable to any diameter by screws, and arranged for inside or outside chucking, and to be readily removable, leaving the table clear for other work.

Table-spindle to be driven into and bolted by flange to lower side of table. Upper bearing to be 11 inches diameter, 10 inches long. Length of spindle under table, 50 inches.

Housings to be 7¼ inches on the face and have bearing on the bed 50 inches long.

Cross-rail to be 21 inches deep and fitted with two boring-heads. Boring-bars (octagonal form preferred) to have a vertical travel of 36 inches.

For feeds and all other details, see general description.

72-inch vertical boring-mill.

To have a clear swing of 73 inches and take work 42 inches high under tools. Driving-cone to have six steps for 4-inch belt, smallest step not less than 8 inches diameter. Cone to be strongly back-geared, giving 12 changes of speed. Back-gear to be about as follows:

Cone-pinion, 30 teeth, ¾-inch pitch.
Back-gear spur, 90 teeth, ¾-inch pitch.
Back-gear pinion, 17 teeth, 1-inch pitch.
Cone-spur, 75 teeth, 1-inch pitch.
Rack-pinion (steel), 17 teeth, 1⅝-inch pitch, 5-inch face.
Table-rack, 100 teeth, 1⅝-inch pitch, 5-inch face.

Table to have diameter of 70 inches and to be 4½ inches deep on outer rim. To be provided with T-slots for holding work, and in addition to have four steel chuck-jaws, operated by screws, and adjustable to any diameter and arranged for inside or outside chucking, and to be readily removable, leaving the table clear for other work.

Table-spindle to be driven into and bolted by flange to lower side of table. Upper bearing to be 11 inches diameter by 16 inches long. Lower step bearing to be 6 inches diameter and 10 inches long. Length of spindle under table, 50 inches.

Housings to be 7¼ inches on the face, and have bearing on the bed 50 inches long.

Cross-rail to be 21 inches deep, and fitted with two boring-heads. Boring bars (octagonal form preferred) with vertical travel of 36 inches.

For feeds and all other details, see general description.

CLASS G.

Specifications for four 36-inch lathes.

Lathe to swing 36 inches over the ways and 27 inches over carriage, and to take 10 feet between centers.

Driving-cone to have five steps for 4-inch belt, smallest step not less than 8 inches diameter. Cone to run on spindle and geared by back-gear to spindle and by triple-gear to face plate. Gearing to be approximately as follows:

Cone-pinion, 24 teeth, ¾-inch pitch	2½-inch face.
Back-gear, 88 teeth, ¾-inch pitch	
Back-gear pinion, 22 teeth, 1-inch pitch	3½-inch face.
Cone spur-gear, 66 teeth, 1-inch pitch	
Face-plate pinion, 14 teeth, 1-inch pitch	3½-inch face.
Face-plate gear, 70 teeth, 1-inch pitch	

Giving 15 changes of speed.

Spindle to be made of open-hearth steel containing not less than ½ per cent. of carbon. Front bearing to be not less than 5 inches diameter by 7 inches long. Back gearing to be not less than 3 inches diameter by 6 inches long. Length of spindle in bearings to be not less than 42 inches.

Spindle-bearings to be made of hard bronze containing 85 per cent. of copper and 15 per cent. of tin. Bearings to have heavy flanges at the ends, and to be carefully scraped to a true bearing on spindle.

Face-plate to be 36 inches in diameter, provided with slots for clamping work, and to be forced on spindle and firmly keyed. Face-plate gear to be a separate casting and bolted to face-plate.

Centers to be of good tool-steel, 2¼ inches diameter, hardened and pointed to inclose an angle of 60 degrees.

Feeds to be suitable for steel and to be positive, driven by gearing from head-stock. To range from $\frac{1}{40}$ inch for the finest to $\frac{1}{10}$ for the coarsest. Reversing-gear for feed to be placed in the head-stock, and change-gear to be provided for cutting screw-threads varying by ⅛ and $\frac{1}{10}$ inch, and ranging from $\frac{1}{20}$ and $\frac{1}{16}$ inch for the finest to 1 inch for the coarsest.

Material for gearing.—All driving-pinions having less than 30 teeth are to be made of steel forging or casting, and all other gears are to be made of strong close-grained cast-iron containing 25 per cent. of cold-blast iron. All gearing to be accurately cut.

Lead-screw to be of steel 2⅛ inches diameter, ½-inch pitch. Lead-screw nut to be operated by cam and to be not less than 7 inches in length.

Feed-rack to be not less than 2 inches wide and ⅝-inch pitch, and to be of steel.

Carriage to be at least 48 inches long; to be fitted to ways on front and back, and bear on the inner way used for tail-stock guide. To be fitted with one heavy compound-rest.

Compound-rest to have base at least 10 inches wide by 16 inches long; to be provided with power cross-feed designed for heavy work. Wing-rest, for turning full swing over ways, to be fitted to front wing of carriage.

Bed to be not less than 28 inches wide; to be provided with 4 ways, 2 for carriage and 2 for head and tail stocks. Cross-girts (box-girder form preferred) to be spaced 24 inches between centers. Depth of bed to be not less than 16 inches.

Tail-stock.—Base to be 20 inches long and 20 inches wide; to be held to bed by 4 heavy bolts. Top to be provided with convenient set-over. Tail-spindle to be of steel, 4 inches in diameter.

All necessary counter-shafts, pulleys, wrenches, and other appliances to complete lathe ready for operations to be furnished. Friction-clutch pulleys for open and crossed belt.

The workmanship must be first-class throughout. All shafts and feed-screws must be of steel, and all bolts of steel or refined iron. All nuts frequently used must be case-hardened.

CLASS H.

Specifications for four 26-inch lathes.

Lathe to swing 26 inches over the ways, and from 16 to 18 inches over the carriage, and to take 7 feet between the centers.

Driving cone to have 5 steps for 3½-inch belt, smallest step to be not less than 6 inches in diameter. To be geared to spindle in a ratio of not less than 12 to 1, giving ten changes of speed.

Spindle to be of open-hearth steel containing not less than ½ per cent. of carbon. Front bearing to be about 4½ inches diameter, and at least 6 inches long; back bearing 2⅝ inches diameter, and at least 4 inches long.

Spindle-bearings to be made of best hard composition containing 85 per cent. copper and 15 per cent. tin. Bearings must be carefully scraped to fit spindle.

Feeds to be positive and driven from the spindle. Two changes by clutch-pin are to be provided in the head-stock. To range from $\frac{1}{40}$ inch for the finest to ⅛ inch for the coarsest.

Compound-gearing to be provided for cutting screw threads varying by ⅛ inch and $\frac{1}{10}$ inch, and ranging from $\frac{1}{20}$ and $\frac{1}{16}$ inch for the finest to $\frac{3}{10}$ and ⅜ inch for the coarsest, respectively.

Face-plate to be 26 inches diameter, and screwed to the end of spindle.

Spindle-centers to be of good tool-steel 1⅝ inches diameter, hardened and pointed to inclose angle of 60 degrees.

Material for gearing.—All gearing of whatever description is to be accurately cut, and to be made of steel or strong close-grained iron containing 25 per cent. of cold-blast iron.

Lead-screw to be of steel, 2 inches diameter, ¼-inch pitch. Lead-screw nut to be operated by cam, and to be not less than 7 inches in length.

Feed-rack to be not less than 2 inches wide and ⅝-inch pitch.

Carriage to have length not less than 42 inches, to be fitted to ways on front and back of bed and bear on the inner way used for tail-stock guide. To be fitted with one heavy compound-rest.

Apron to be fitted with feed gear for longitudinal feed to carriage and cross-feed to compound-rest, and lead-screw nut for screw-cutting. Reversing-gear for longitudinal and cross-feeds to be placed in apron, and safety-stop is to be provided to prevent feed-gear and lead-screw nut from being in operation at the same time.

Compound-rest to have base at least 8 inches wide by 13 inches long. To be provided with power cross-feed designed for heavy work. Wing-rest for turning full *swing* over ways to be fitted to front wing of carriage.

Bed to be not less than 25 inches wide. To be provided with four ways, two for carriage and two for head and tail stocks. Cross-girts (of box-girder form preferred) to be spaced 24 inches between centers. Depth of bed to be not less than 15 inches.

Tail-stock to have base at least 15 inches long and 15 inches wide. To be held to bed by two heavy bolts. Top to be provided with convenient set-over. Tail-spindle to be of steel, 3½ inches diameter.

The workmanship must be first class throughout. All shafts and feed-screws must be of steel, and all bolts of steel or refined iron. All nuts frequently used must be case-hardened.

All necessary counter-shafts, pulleys, wrenches, and other appliances to complete lathe ready for operation to be furnished with lathe. Friction-clutch pulleys to be provided for crossed and open belt.

CLASS I.

Specifications for four 20-inch lathes.

Lathes to swing 20 inches over the ways and 14 inches over the carriage, and to take 4 feet 6 inches between the centers.

Driving-cone to have four steps for 3-inch belt, smallest step to be not less than 6 inches diameter, and geared to spindle in ratio of about 10 to 1, giving eight changes of speed.

Spindle to be made of open-hearth steel containing not less than ½ per cent. of carbon. Front bearing to be 3½ inches diameter by about 5 inches long. Back bearing to be not less than 2¾ inches diameter and 3½ inches long. Length of spindle in bearings to be from 28 to 30 inches. Hole through full length of spindle 1¼ inches.

Spindle-bearing to be made of hard bronze, containing 85 per cent. of copper and 15 per cent. of tin. Bearings to have heavy flanges at the ends and to be carefully scraped to fit spindle.

Face-plate to be 20 inches diameter and screwed to front end of spindle.

Centers to be of good steel 1 5/16 inches diameter, hardened, and pointed to inclose an angle of 60 degrees.

Feeds to be by gearing or belt on step-cone driven from spindle, with two changes by clutch-pin provided in head-stock, making four changes of feed. Feeds to range from 1/40 inch for the finest to 1/16 inch for the coarsest.

Compound-gearing to be provided for cutting screw-threads varying by ⅛ to 1/16 inch, and ranging from 1/30 to 1/16 inch for the finest to 3/16 and ⅜ inch for the coarsest, respectively.

Material for gearing.—All gearing of whatever description is to be accurately cut, and made of steel or strong close-grained iron containing 25 per cent. of cold-blast iron.

Lead-screw to be of steel, 1¾ inches diameter, ½-inch pitch. Lead-screw nut to be operated by cam and to be not less than 5 to 6 inches in length.

Carriage to be 28 inches long. To be fitted to ways on front and back of bed and bear on the same way used for tail-stock guide. To be fitted with one heavy compound-rest.

Apron to be fitted with gear for longitudinal-feed to carriage and cross-feed to compound-rest, and lead-screw nut for screw cutting. Reversing-gear for feeds to be put in apron, and safety-stop to be provided to prevent feed-gear and lead-screw nut from being in operation at the same time.

Compound-rest to have base from 7 to 8 inches wide by 12 inches long. To be provided with power cross-feed designed for heavy work. Wing-rest for turning full swing over ways to be fitted to front wing of carriage.

Bed to be not less than 20 inches wide. To be provided with four ways, two for carriage and two for head and tail stocks. Sides to be joined by web across the top of bed. Depth of bed to be not less than 14 inches.

Tail-stock to have base 13 to 14 inches each way. To be held to bed by two heavy bolts. Top to be provided with convenient set-over. Tail-spindle to be of steel, 2¾ inches diameter. The workmanship must be first class throughout. All shafts and feed-screws must be of steel, and all bolts of steel or refined iron. All nuts frequently used must be case-hardened.

All necessary counter-shafts, pulleys, wrenches, and other appliances to complete lathe ready for operation to be furnished with lathe. Friction clutch-pulleys for crossed and open belt to be provided on counter.

CLASS K.

Specifications for one 24-inch slotter.

This machine is to slot to a center of at least 72 inches, if possible 80 inches. To be fitted with compound and circular tables. Longitudinal traverse to be 40 inches, and transverse traverse of tables 36 inches. Circular table to be 50 inches diameter.

Ram driven by rack, pinion, and tangent-gear, with quick return on up-stroke. Ram-guide adjustable for height and having 26 inches clear space under it when in the highest position.

Ram to be made of hard, close-grained iron containing 25 per cent. of cold-blast iron. To be provided with rack on the back not less than 1¾-inch pitch, 6½-inch face. Ram to have adjustable reverse tappets on its face, and lower end is to be provided with swinging tool-holder for release-tool and tool-holder slots for fixed tool. Length of ram to be not less than 6 feet, and to be well counterbalanced, counterbalance to go into pit below floor.

Rack-pinion to be of sound steel casting or forging. To have not less than 19 teeth, 1¾-inch pitch, 6½-inch face.

Tangent-gear to be attached to pinion-shaft and surrounded by casing. Worm and gear to be made of cold-blast iron, and worm to be well provided with antifriction washers to take up end thrust. Pitch of worm to be not less than 2 inches. Worm to be driven by open and cross-belts on large-sized pulleys so proportioned as to give a return speed to ram of two to one.

Ram-guide to be adjustable vertically to heights ranging from 10 to 26 inches above table. To be provided with screws and gears for easy adjustment, and with ample surface for wear of ram.

Tables.—Circular table to be 50 inches diameter, fitted with center guide into the square table below, and provided with feed worm-wheel of hard and durable bronze, 37 inches diameter, ¾-inch pitch, and feed-worm of good machinery steel, and provided also with center stud for circular work. Square table to be not less than 36 by 42 inches, and fitted with four corner clamps for clamping circular table in place. Lower table to be not less than 36 inches wide by 72 inches long.

Feeds to be self-acting in all directions, and to consist of circular feed for upper table, transverse feed for intermediate table, 36 inches, and longitudinal feed for lower table, 40 inches. Feed to be operated always at the upper end of stroke. Feeds to range from finest $\frac{1}{100}$ to coarsest ½ inch on the largest diameter.

Column at juncture with base to be not less than 24 inches wide and 36 inches deep, with metal so disposed as to best resist the strains. Base to be not less than 24 inches wide and 26 inches deep, provided with large wearing surface for lower table.

Gearing.—All gearing must be accurately cut, and unless otherwise specified shall be made of strong close-grained iron containing 25 per cent. of cold-blast iron.

All shafts and screws must be made of a good quality of steel, and all bolts shall be made of steel or refined iron, and all nuts frequently used shall be case-hardened.

Bearings for the worm and pinion-shafts shall be bushed with bronze.

The workmanship throughout to be first class. All surfaces in contact with moving parts must be carefully scraped to good true bearings. All necessary counter-shafts, pulleys, wrenches, and other appliances to complete machine ready for operation must be furnished.

CLASS L.

Specifications for one 18-inch slotter.

Machine to be driven by crank with Whitworth quick-return motion. Distance from column to point of tool to be not more than 30 inches.

Compound table to be fitted to point of column with longitudinal, transverse, and circular feeds in all directions by power.

Feeds to take place always at upper end of stroke, never during the cut or while the tool is on the return. Range of feeds to be from $\frac{1}{100}$ inch for the finest to ½ inch for the coarsest on a diameter of 50 inches.

Ram-guide to be adjustable for various heights, and to leave about 22 inches clear between it and circular table when in the highest position.

Material.—The driving-shaft to be made of open-hearth steel not less than 4½ inches in diameter, containing not less than ½ per cent. carbon. All other shafts and feed-screws to be made of good machinery steel, and all bolts to be made of steel or refined iron. All nuts frequently used to be case-hardened.

Gearing driving-pinion to be of forged steel, and all other gearing to be of steel, or strong close-grained cast-iron containing 25 per cent. of cold-blast iron.

Counter-shaft to be provided with pulleys for two changes of speed.

Driving-cone to have four steps for 4½ or 5 inch belt, ranging from about 14 to 26 inches in diameter, giving two changes in counter-shaft, eight speeds to ram. Slowest speed to be not more than 10 or 12 feet per minute. Cone to be geared to driving-crank in ratio of 8 to 1, or preferably 9 to 1. Main driving-gear to be 1-inch pitch, 3½-inch face, and about 42 to 45 inches pitch diameter. Largest step in cone to be extra heavy to serve as balance-wheel.

Ram to be connected to crank by steel forged rod of heavy section not less than 38 inches long. Stroke of ram to be 19 inches. Ram to be supported in back by adjust able guide. Ram to be counterweighed and provided with screw for hand adjustment to any vertical position. Length of ram to be at least 63 inches, more length desirable. In addition to clamps for holding rigid tools, the ram is to be provided with a swinging tool-holder on the lower end to take release-tool.

Compound-tables.—The lower table should be 48 inches long by 32 inches wide, and have bearing on bed 24 by 32 inches.

Intermediate table to be 32 inches square, and have transverse traverse of 30 inches. Circular table to be 48 inches in diameter, and fitted with worm-wheel of hard bronze, located under circular table, and protected from chips and dust.

Cranks for moving tables by hand to be placed in convenient position for operator, and feeds arranged to be easily engaged or disengaged.

Column to be not less than 21 inches wide and, as nearly as possible, 30 inches deep, with front extended out to form bed for tables. Length of bed to be sufficient to allow circular slotting on a diameter of 50 inches.

Workmanship and material to be first class throughout.

All necessary counter-shafts, pulleys, hangers, wrenches, and other appliances to complete machine ready for operations to be furnished with machine.

CLASS M.

Specifications for one 26-inch, one 32-inch, one 38-inch and one 44-inch planer.—General description.

Machines are to be driven by tangent-gearing transmitting motion to the table-rack.

Feeds to be by power in all directions, and actuated by positive gearing and not by friction.

Bed and table to be in all cases of extra depth, with ample bearings in ways. Table-ways are to be lubricated by conical brass rollers inserted at suitable distances in the bed. Sides of bed to be joined by heavy box-girder at housing cheeks and intervals.

Housings to be doubled-webbed, with wide faces and ample depth in the back. Front of housings must in all cases be accurately scraped to make perfect bearing against the cross-rail.

Cross-rail to be of extra depth and have arched back cored out. To be scraped on face to perfectly fit the head or heads, and back resting against housings to be scraped to a perfect bearing.

Driving-pulleys to be actuated by open and cross belts shifted by easy cam movement. Pulleys to be placed directly on worm-shaft, said shaft to stand parallel with planer.

Driving-gear.—The worm and worm-wheel driving table, together with the intermediate gearing and table-rack, are to be made of strong close-grained iron containing not less than 25 per cent. of cold-blast iron. The tangent-gearing shall in all cases be triple-pitch.

Cutting-speed to be for steel 12 to 14 feet per minute.

Quick return to table to be provided. On smaller sizes return to range from 70 to 80 feet per minute, and on larger sizes from 60 to 70 feet. All parts subject to strains on account of sudden change of speed to be made extra heavy.

Driving-shafts to be in all cases of open-hearth steel containing not less than one-half per cent. of carbon. Bearings for shafts to be bushed with hard bronze bushings composed of 85 per cent. copper and 15 per cent. tin.

Material and workmanship to be first class throughout. All shafts and feed-screws not otherwise specified are to be made of steel, and all gearing to be of steel or strong close-grained iron containing not less than 25 per cent. of cold-blast iron.

All necessary counter-shafts, hangers, pulleys, wrenches, and other appliances to complete machines ready for operation are to be furnished with planers.

26-inch by 26-inch by 6-foot planer.

To plane 26½ by 26½ inches in the clear, and 6 feet long. One head fitted to cross-rail.

Table to be 20 inches wide and not less than 7 feet 4 inches long. Distance between ways to be not less than 13 inches, and width of ways to be not less than 3 inches.

Rack bolted to table, accurately cut, 1-inch pitch, 3½-inch face.

Bed to be 18 inches deep, with sides joined by heavy box-girder at housing cheeks and intervals. To be fitted with four brass conical rollers for lubricating table.

Housings to have face 4½ inches wide and depth on bed 25 inches. Double-web form of housings preferred.

Cross-rail to have depth on face not less than 10 inches; to be fitted with one head arranged for cross and down feeds in all directions. Top of rail to be square-gibbed for head. Cross-rail to be elevated by hand.

Driving-pulley to be not less than 21 inches diameter, driven by 1¾-inch belt, and driving table through tangent-gear and rack-pinion. Belt velocity to be not less than 30 times velocity of table.

Return of table to be 80 feet per minute.

32-inch by 32-inch by 8-foot planer.

To plane 32½ by 32½ inches in the clear, and 8 feet long. One head fitted to cross rail.

Table to be 26½ inches wide and less than 9 feet 4 inches long. Distance between ways to be not less than 16 inches, and ways to be not less than 3½ inches wide.

Rack to be bolted to table, and to be accurately cut, 1½-inch pitch and 4½-inch face.

Bed to be not less than 19 inches deep, with sides joined by heavy box-girder at housing-cheeks and at intervals. To be fitted with four brass conical rollers for lubricating table.

Housings to have face 5 inches wide and bearing on bed 32 inches long, and to have double-web form.

Cross-rail to have depth on face of not less than 13 inches. To be fitted with one head arranged for cross and vertical feeds in all directions. Top of rail to be square-gibbed for head. Cross-rail to be elevated by hand.

Driving-pulley to be not less than 24 inches diameter, driven by 2-inch belt, and driving table through tangent-gear and rack-pinion. Belt velocity to be not less than 32 times velocity of table. Return of table to be 70 feet per minute.

38-inch by 38-inch by 8-foot planer.

To plane 38½ by 38½ inches in the clear, and 8 feet long. Two heads on the cross rail.

Table to be 32 inches wide and not less than 10 feet long. Distance between ways to be not less than 20 inches, and width of ways not less than 4 inches.

Rack to be accurately cut, 1½-inch pitch, 5-inch face, and bolted to table.

Bed to be 20 inches deep, with sides joined by heavy box-girder at housing cheeks and at intervals. Bed to be fitted with four or more conical brass rollers for lubricating table.

Housings to have face at least 7½ inches wide, and bearings on bed about 40 inches long.

Cross-rail to have depth on face not less than 14½ inches. To be fitted with two heads, arranged for cross and vertical feeds in all directions. Top of rail to be square-gibbed for head. Rail to be elevated by power.

Driving-pulley to be not less than 26 inches diameter for 3-inch belt, and drive the table through tangent-gearing, rack-wheel, and pinion. Belt velocity to be not less than 40 times the velocity of the table. Return of table to be 70 feet per minute.

44-inch by 44-inch by 10-foot planer.

To plane 44½ by 44½ inches in the clear, and 10 feet long. Two heads to be fitted for cross-rail; two side-heads to be fitted, one on each housing.

Table to be 36 inches wide and not less than 12 feet long. Distance between ways to be not less than 24 inches, and ways to be not less than 4½ inches in width.

Rack to be accurately cut, 1½-inch pitch and 6½-inch face, and bolted to table.

Bed to be not less than 21 inches deep, with sides joined by heavy box-girder at housing cheeks and at intervals. Bed to be fitted with 6 conical brass rollers for lubricating table.

Housings to have not less than 7½ inches face, bearing on bed to be 42 inches long and fitted with ways for side heads.

Cross-rail to have depth on face not less than 15½ inches. To be fitted with two heads, arranged for cross and vertical feeds in all directions. Top of rail to be square-gibbed for heads. Rail to be elevated by power.

Driving-pulley to be not less than 26 inches diameter, and drive the table through tangent-gearing, pinion, and rack-wheel. Belt velocity to be not less than 40 times the velocity of table. Return of table to be 60 feet per minute.

Side-heads.—One side-head to be fitted to each of the housings. Side-head saddles to have bearing on housings 12 inches long and bearing for slide 18 inches long. *Saddles* to be fitted with adjustable slides, upon which are mounted swiveling tool-box and tool-apron. Tool-apron to be fitted with spring to drop apron into place.

and hand feeds to be applied to side-heads, and the same are to be counter-
d to enable easy manipulation by hand. Side-heads to be so adjusted on hous-
;o drop down to allow the cross-rail coming close to the table. Side-heads
t all times allow work the full width of space between housings to pass be-
them.

CLASS N.

Specifications for two 26-inch shapers.

machine is to plane longitudinal grooves in breech-blocks up to 17¼ inches di-
and 25¼ inches length. It is to be arranged for work of a general nature with
wide range of feeds.

ing speed for steel to be 13 feet per minute. Stroke of cutter-bar to be 26¼

r-bar to be driven by connection to driving-crank with variable stroke. Crank
rovided with "Whitworth" quick-return motion, approximately two to one.

t of bed to extend to floor, and be fitted with two tables, one containing vise;
r feed for ordinary work to be provided in the center of bed.

ng cone to have four steps for 3¼-inch belt, ranging about from 11 to 20 inches
er, back-geared, giving eight changes of speed. Cone geared to driving-crank
› of about 28 to 1. Main driving-gear to be not less than 27 inches diameter,
pitch and 3-inch face; driving pinion of forged steel.

r-bar to be of heavy section, U-shaped preferred, with square ways on the
side, and to have bearing on saddle not less than 10 inches wide by 48 inches

th of cutter-bar not less than 72 inches.

er-bar to have on its face a tool-head with clamps and studs, set over by tan-
ar, vertical movement of 8 inches, and automatic up-and-down feed. Adjust-
f stroke during cutting desirable.

ecting arm to be a forging of heavy rectangular section, not less than 42 inches
n centers. To be adjustable on driving-crank to any length of stroke, and
ble on the ram by a screw and hand-crank, placed to be operated from the
de of machine to allow cutter-bar to be set to any desired position.

'e to have bearing on bed not less than 28 inches square, accurately fitted to
d provided with gibs for ways to take up wear. Saddle to be arranged to be
on bed in either direction without going to end of bed to disconnect feed, and
further provided with pinion and large hand-wheel, gearing into main gear
v adjusting the stroke without doing the same by belt.

—Saddle-feed to be by heavy screw, not less than 1¾ inches in diameter, to
from $\frac{1}{100}$ to $\frac{1}{10}$ inch. Feed to be reversible. Circular feed to be provided for
l in center of bed for circular work.

to be about 100 inches long and not less than 28 inches wide on top. To be
ed with square ways, and front to extend down to floor, legs projecting about
s in front on each end of bed. Front to be T-slotted to receive work. Saddle
› 70 inches movement on bed.

-tables.—To be two in number; to be movable lengthwise on the bed, and ad-
e on same by screws operated by hand-cranks. One table to be of box-form,
es square, and T-slotted on top and sides to receive work. One table to be
ed with movable platen 24 inches square and heavy swiveling-vise. Tables to
ed and lowered by screw and hand-crank, so placed that stooping is avoided.

al center-head to consist of heavy slide, not less than 6 inches deep by 12 inches
Slide to be provided with head fitted with center revolved by indexed tan-
ar, and with tail-block fitted with adjustable center. The whole to be very
e, calculated to plane lengthwise in breech-blocks 17¼ inches diameter by 25¼
long, breech-blocks being mounted on mandrels and placed between the cen-
Automatic circular-feed, transmitted through the tangent-gear and operated
movement of cutter-bar, to be provided. Finest feed to be not over five-
dths of 1 inch.

stock center to have set-over for cutting tapers. Cutter-head to be mounted
box-shaped work-table and securely clamped.

manship and material to be first class throughout. All shafts and feed-screws
f good machinery steel; all bolts to be of refined iron, and all nuts frequently
be case-hardened.

ng to be accurately cut and to be made of strong close-grained iron containing
ent. of cold-blast iron.

earing surfaces must be accurately scraped.

ter-shafts, hangers, pulleys, wrenches, and all appliances to complete machine
or operation to be furnished with machine.

CLASS O.

Specifications for four 18-inch shapers.

Cutter bar to have 18¾ inches stroke and quick return by Whitworth motion. Bar to be not less than 48 inches long, and to have bearing on saddle not less than 8 inches wide by 30 inches long. Bar to be fitted to saddle with square gibs, and to be adjustable by screw operated by hand-crank on front of machine.

Head to be operated by tangent-gear; vertical-feed to be automatic.

Saddle to have 60 inches traverse on bed with bearing not less than 24 by 24 inches, or like area. Saddle to have opening-nut on feed-screw, and to be quickly movable on bed by rack and pinion.

Feed. Saddle-feed to be by heavy screw, and range from one one-hundredth to one tenth of 1 inch. Feed to be reversible.

Driving cone to have four steps for 3½-inch belt, smallest step to have not less than 10 inches diameter. Counter-shaft to be arranged with two sets of pulleys, giving eight speeds to cone. Cone to be geared to driving crank in a ratio of about 7 to 1.

Bed to be at least 22 inches wide on top and front extended down to the floor, and provided with T-slots to hold work.

Circular-feed mandrel to be placed in center of front bed. Mandrel to be not less than 2½ inches diameter, and fitted to revolving-brush, provided with automatic feed by tangent gear.

Work tables to be two in number, placed on the front of bed, and movable lengthwise on the same by screws operated by hand-cranks. One table to have box-form, not less than 18 by 18 inches, and T-slotted on top and sides. One table to have square platen, not less than 18 by 18 inches, removable, to be replaced by swiveling-vise.

Vertical adjustment of tables by screw and hand cranks, so placed that stooping is avoided. Adjustment to be 18 inches.

1 pair of centers of heavy design, for shaping circular work, to be provided.

Workmanship and material to be first class throughout.

Gearing to be accurately cut, and to be of steel or strong close-grained iron containing 25 per cent. of cold-blast iron. All shafts and screws to be of good machinery steel, and all bolts to be of refined iron. All nuts frequently used must be case-hardened.

All bearing-surfaces must be accurately scraped to bearing.

Counter-shaft, hangers, pulleys, wrenches, and all other appliances to complete machine ready for operation to be furnished.

CLASS P.

Specifications for one universal radial drilling machine.

The machine to consist of a heavy L-shaped sole-plate, upon which is mounted the drill column, arranged to revolve about a fixed sleeve on the sole plate. Upon the column [illegible] a long sleeve [illegible] arm carrying the drill-head.

[illegible] to revolve to any position from [illegible] [illegible] spindle to be [illegible]

Max [illegible] inches, and [illegible]

[illegible]

[illegible] allowing column to revolve [illegible]

[illegible] geared [illegible]

[illegible] provided [illegible]

[illegible]

[illegible] arm [illegible]

[illegible]

[illegible] back gear

[illegible]

[illegible] and [illegible]

[illegible]

[illegible] and reverse

[illegible] and the other [illegible]

[illegible] and to have [illegible]

[illegible] and quickly [illegible]

[illegible] the saddle [illegible]

fitted the swiveling-head carrying drill-spindle. Head to swivel from vertical an horizontal position.

Spindle to be of open-hearth steel containing at least one-half per cent. carbon, inches diameter, and having vertical traverse of about 15 inches.

Feed.—Two changes of power-feed to be provided by positive gearing operated b clutch-pin. Feed to be transmitted through screw provided with double nut, a ranged to allow all lost motion to be taken out.

Gearing.—All small pinions to be of forged steel, and all other gear to be of stron close-grained cast-iron containing not less than 25 per cent. of cold-blast iron. A shafts and feed-screws to be of good quality machinery steel, and all bolts to be refined iron. All nuts frequently used to be case-hardened.

Workmanship and material to be first class throughout.

Counter-shaft, pulleys, hangers, wrenches, and all other appliances to make machine complete ready for operation are to be furnished with drill.

CLASS R.

Specifications for one 24-inch, one 30-inch, and one 36-inch vertical drill.—Gener description.

Drills to consist of a strong, substantial column mounted on heavy sole-plat Column to reach over at top and take upper end of drill-spindle. Driving-cone wit back gear to be supported by bracket at the upper end of column. Cone to be drive by belt coming from lower cone, placed near the base of column.

Lower end of drill-spindle to be supported by head movable vertically on the fac of column, and fitted to column by ways and clamping-gib.

Feed to spindle is by rack-sleeve surrounding spindle, and taking up the thrust o spindle by annular washers of vulcanized fiber.

Table may be circular, but preference will be given to square or rectangular compound table. Table to be provided with slots for clamping work, and mounted on substantial bracket or arm, swiveling on the columns and having vertical adjustmen by rack and pinion.

Arm to be provided with clamps to hold it firmly in position on column and clam table in place.

24-inch drill.

Driving-cone to have four steps for 2-inch belt. largest step not less than 9 inch diameter. Cone geared to spindle in ratio of about 6 to 1.

Spindle to be not less than 1¾ inches diameter, and made of open-hearth steel containing one-half per cent. of carbon. Spindle to be inclosed in feed-rack sleeve, an to have traverse of at least 8 inches. Spindle to be provided with anti-frictio washer. to take up thrust.

Drill-head to be accurately fitted to ways on the front of column and movable vertically on the same through a distance of not less than 21 inches, and provided wit clamp to hold head in position.

Counter-weight.—Counter-weight to be provided for balancing drill-head and spindle. Chain and sheaves to be so arranged that one weight will balance both hea and spindle. Weight to hang inside the column.

Feed.—Two changes of feed by power to be provided, and hand-feed and quic return by hand to be provided for.

Column to have lower end turned to take table-support and front planed for dril head. Back to column provided with arms to take driving-cones and back-gea Diameter of column to be not less than 8 inches in the part turned to receive table.

Drill-head to have bearing on column 12 inches long and 6¼ to 7 inches wide, counter-balanced and provided with clamp-gib to hold to column.

Table.—Compound table preferred. To be 24 inches diameter if circular.

Table-arm to be bored to fit column and have bearing on column not less than 1 inches deep.

Sole-plate to be not less than 3 inches in depth, about 38 inches long, and 20 inche wide, to be accurately bored to a driving fit on column.

Workmanship and material to be first class throughout. All bearings to be accurately fitted. All shafts to be of good machinery steel unless otherwise specified.

All gearing to be of steel or strong close-grained iron, containing 25 per cent. cold-blast iron. All bolts to be of refined iron, and all nuts frequently used to be case-hardened.

Driving-pulleys to be placed directly on machine, and all wrenches and other appliances required to complete machine ready for operation to be furnished wit drill.

Distance from sole-plate to lower end of spindle when in its highest position to 4 feet 6 inches or more.

30-*inch drill.*

Driving-cone to have four steps for 2¼-inch belt, largest step not less than 12 inches diameter. Cone-geared to spindle in ratio of about 10 to 1. Back-geared, giving eight changes of speed.

Spindle to be not less than 2¼ inches diameter, and made of open-hearth steel containing ½ per cent. of carbon. Spindle to be inclosed in feed-rack sleeve, and to have traverse of 12 inches. Spindle to be provided with anti-friction washer to take up thrust.

Drill-head to be accurately fitted to ways on the front of column, and movable vertically on the same through a distance of at least 21 inches, and provided with clamp to hold head in position.

Counter-weight.—Counter-weight to be provided for balancing drill-head and spindle. Chain and sheaves to be so arranged that one weight will balance both head and spindle. Weight to hang inside of column.

Feed.—Three changes of feed by power to be provided, and hand-feed and quick return by hand to be provided for.

Column to have lower end turned to take table-support and front planed for drill-head. Back of column to be provided with arms to take driving-cones and back-gear. Diameter of column to be not less than 10 inches in the part turned to receive table.

Drill-head to have bearing on column about 14 inches long and 8 to 9 inches wide, counterbalanced and provided with clamp-gib to hold to column.

Table.—Compound table preferred. Table, if circular, to be 30 inches in diameter and swing 30 inches.

Table-arm to be bored to fit column, and have bearing on column about 14 inches deep.

Sole-plate to be not less than 5 inches in depth, 48 inches long, and 30 inches wide, and to be accurately bored to a driving fit on column.

Workmanship and material to be first-class throughout. All bearings to be accurately fitted. All shafts to be of good machinery steel unless otherwise specified. All gearing to be of steel or strong close-grained iron containing 25 per cent. of cold-blast iron. All bolts to be of refined iron, and all nuts frequently used to be case-hardened. Driving-pulleys to be placed directly on machine, and all wrenches and other appliances required to complete machine ready for operation to be furnished with drill.

Distance from sole-plate to lower end of spindle when in its highest position to be not less than 4 feet 9 inches.

36-*inch drill.*

Driving-cone to have four steps for 2½-inch belt, largest step not less than 15 inches diameter. Cone-geared to spindle in a ratio of 10 to 1. Back-geared, giving eight changes of speed.

Spindle to be not less than 2½ inches diameter and made of open-hearth steel containing ½ per cent. of carbon. Spindle to be inclosed in feed-rack sleeve, and to have traverse of at least 14 inches. Spindle to be provided with anti-friction washer to take up thrust.

Drill-head to be accurately fitted to ways on the front of column, and movable vertically on the same through a distance of not less than 21 inches, and provided with clamp to hold head in position.

Counter-weight.—Counter-weight to be provided for balancing drill-head and spindle. Chain and sheaves to be so arranged that one weight will balance both head and spindle. Weight to hang inside the column.

Feed.—Three changes of feed by power to be provided, and hand-feed and quick return by hand to be provided for.

Column to have lower end turned to take table support and front planed for drill-head. Back of column provided with arms to take driving-cones and back-gear. Diameter of column to be not less than 11 inches in the part turned to receive table.

Drill-head to have bearing on column not less than 15 inches long and 9 to 10 inches wide, counter-balanced and provided with clamp-gib to hold to column.

Table.—Compound table preferred. Table if circular to have 36 inches diameter and swing.

Table arm to be bored to fit column, and have bearing on column at least 15 inches deep.

Sole-plate to be not less than 5½ inches in depth, about 4 feet 8 inches long, and 3 feet 8 inches wide, and to be accurately bored to a driving fit on column.

Workmanship and material to be first class throughout. all bearings to be accurately fitted. All shafts to be of good machinery steel unless otherwise specified. All gearing to be of steel or close-grained iron containing 25 per cent. of cold-blast iron. All bolts to be of refined iron, and all nuts frequently used to be case hardened.

Driving-pulleys to be placed directly on machine, and all wrenches and other appliances required to complete machine ready for operation to be furnished with drill.

Distance from sole-plate to lower end of spindle when in its highest position to be not less than 5 feet.

Specifications for one 50-inch drill to take work 50 inches diameter.

Machine to consist of a heavy sole-plate, on which is mounted the column, carrying on its back, at upper end, the driving-cone and back-gear. The upper end of column reaches over and forms bearing for the upper and lower ends of spindle.

Lower part of column to be turned to fit table arm and provided with heavy flange to bolt to sole-plate. Table-arm to be fitted to column and arranged to revolve about the same, and fitted with square compound table, and provided with vertical adjustment. Counter-shaft with driving pulleys to be provided for this machine.

Driving-cone to have four steps for 3-inch belt. Largest cone to be about 18 inches diameter, and geared to spindle in ratio of about 12 to 1, provided with back gear, giving eight changes of speed.

Spindle to be not less than 3½ inches diameter and made of open-hearth steel containing one-half per cent. of carbon. To have traverse of 15 inches and provided with quick return by lever, and well provided with anti-friction washers to take up the thrust.

Feeds to be driven by belt, to be three in number, and transmitted to spindle by rack-sleeve. Counter-balance to be provided for spindle, also hand-feed.

Table-arm to have bearing on the column from 16 to 18 inches deep. To be capped and provided with clamp-bolts to clamp to column. To be adjusted vertically by screw bedded in column and arranged to swivel around column. To be provided with stop-pin to bring center of arm exactly under center of spindle.

Arm to project from edge of column about 40 inches and to be fitted with ways for square table at least 18 inches wide. Arm to be provided with bored hub to receive bushings for boring-bars. Hub to bore to 4½ inches.

Square table to be 30 inches square and fitted to perfect bearing on table-arm, and provided with gib to take up wear. Table to move laterally on arm by screw operated by hand-wheel underneath. Table to have opening through center to allow boring-bar to reach into table-arm.

Column to be turned to 12½ inches diameter to receive table-arm. Front of column to have slot accurately planed to receive bronze nut for elevating and lowering table-arm. Column to contain all the bearings for driving-cone, back-gear, and spindle. Lower spindle-bearing to receive bronze bush not less than 10 inches long, bored to fit spindle. Flange on lower end of column to be at least 20 inches diameter, not less than 1¾ inches thick, and bolted to sole-plate by at least four heavy bolts.

Sole-plate to be not less than 7 inches thick, 6 feet long, and 3 feet 6 inches wide. To be provided with slots for clamping work, and bored to 4½ inches exactly under center of spindle to take boring-bars. Distance from sole-plate to lower end of spindle to be 56 inches.

Material and workmanship to be first class throughout. All bearings must be accurately fitted. All gearing to be of steel or strong close-grained iron, containing 25 per cent. of cold-blast iron.

All shafts not otherwise specified to be of good machinery steel, and all bolts to be of refined iron. All nuts frequently used to be case-hardened. Counter-shaft pulleys, hangers, wrenches, and all other appliances to complete machine ready for operation to be furnished with drill.

CLASS 8.

Specifications for one 60-inch horizontal boring and drilling machine.

This machine is to bore to a center of 60 inches diameter. Longitudinal table to be 7 feet long, and fitted with compound table surmounted by circular table. Outer end of longitudinal table to be supported by a yoke, which also forms the bearing for the end of boring-bar.

Driving-cone to have five steps for 3½-inch belt, ranging from about 8 to 18 inches diameter. Cone to be strongly back-geared to spindle sleeve in ratio of 10 to 1, giving ten changes of speed. Speed to be adapted for steel.

Spindle sleeve to be of strong close-grained cast-iron, and running in brass bearings composed of 90 copper and 10 tin.

Spindle to be of open-hearth steel, containing one-half per cent. of carbon. Diameter to be 4 inches. Spindle to have traverse of 4½ feet, obtained by two settings of same. Spindle to have quick return by hand.

Feeds to be adapted for steel. To be four in number, two for drilling and two for boring, driven by positive gearing from head-stock, and transmitting motion to spindle by rack and pinion, or otherwise. All hand-wheels and levers for operating spindle and feeds by hand to be in convenient location in front of head-stock.

Longitudinal table to be 7 feet long and 24 inches wide, and fitted to ways on front of head-stock, and provided with clamp-gibs on same. Table to be supported at the outer end in yoke and fitted with elevating-gear for hand and power.

Compound table.—Intermediate table to be fitted to longitudinal table; to be 24 inches wide and 36 inches long.

Cross table to be fitted to intermediate table; to be 36 inches wide and about 5 inches long.

Circular table to be mounted on cross table; to be 48 inches in diameter, and provided with special power feed for circular milling. Feed to be transmitted to circular table by tangent-gear. Table to be provided with clamp-gibs for holding in position when used for other purposes. Feed to range from one-twentieth inch per revolution for the finest to one-fourth inch for the coarsest, or diameter of 42 inches. Feeds to be four in number.

Facing-head to be provided to go on flange of spindle-sleeve.

Head-stock to be of strong box form, with interior arranged for tool-closet.

Sole-plate to be at least 7 inches deep and 30 inches wide and provided with lugs for foundation-bolts.

Elevating-screws to be of good quality machinery steel, not less than 3½ inches in diameter, and fitting into nuts not less than 7 inches long. Pitch to be from one-third inch to one-half inch.

Material.—All pinions of small diameter to be made of steel-forgings, and all other gearing to be close-grained cast-iron containing 25 per cent. of cold-blast iron. All shafts and feed-screws to be made of good machinery steel, and all bolts of steel or refined iron. All nuts frequently used to be case-hardened.

Workmanship and finish to be first class throughout.

All necessary counter-shafts, pulleys, hangers, wrenches, and other appliances to complete machine ready for operation to be furnished with machine.

CLASS T.

Specifications for one horizontal boring, drilling, and milling machine.

This machine is to bore anywhere in a space of 9 feet wide by 6 feet high.

Machine to consist of a heavy column 10½ feet high, mounted on a bed-plate approximately 14 feet long. The column to be moved along the bed-plate by power operating through worm-gear and rack, and to have horizontal movement of 9 feet on bed. The face of column to be not less than 30 inches wide, fitted with flat ways, upon which is fitted a heavy saddle 40 inches square, carrying the spindle.

Saddle to be accurately fitted to face of column and provided with gib to take up wear. Saddle to be 40 inches square and counterbalanced by weight hung inside the column; weight to be built up of pieces easily handled. Saddle to have vertical travel of 6 feet by heavy steel screw.

Boring-spindle to be 5½ inches in diameter; to be made of open-hearth steel containing ½ per cent. of carbon. Spindles to be driven by two splines ⅝ inch wide, and slide in a heavy revolving sleeve of strong cast-iron, driven in either direction, controlled by reversible lever conveniently placed on saddle. Spindle to have traverse of 4 feet through sleeve.

Spindle-feed to be transmitted to spindle by rack and pinion. Eight changes of feed to be provided, ranging from $\frac{1}{80}$ inch to $\frac{1}{10}$ inch per revolution. Hand-feed and quick return by hand to be provided.

Spindle-sleeve to revolve in bearings, composed of 90 parts copper and 10 parts tin.

Feeds for milling.—Six feeds, ranging from $\frac{1}{64}$ inch to ½ inch per revolution of spindle, to be provided for the column and saddle. To be reversible in either direction, horizontally for feeding column and vertically for feeding-saddle. In addition, a quick traverse motion of 60 inches per minute, reversible in either direction, to be provided for the column and saddle. All of the above feeds to be controlled by hand-levers conveniently placed on the front of saddle. All speeds to be suitable for steel.

Bed to be 54 inches wide and 20 inches deep at least. To be fitted with flat ways for column. Web to be carried across the top without openings. Center part of bed to be depressed the full length and receive the driving and feed-shafts and feed-rack. Column bearing on bed to be 54 inches wide, 57 inches long.

Driving-cone to have six steps for 4-inch belt, ranging from 9 inches to 22 inches diameter. To be back-geared, giving twelve changes of speed. Cone to be geared to spindle in a ratio of from 18 to 1 or 20 to 1. Motion from cone to be transmitted by heavy longitudinal shaft running under column the full length of bed, shaft to be at least $2\frac{15}{16}$ inches diameter. Vertical shaft in column to receive motion from longitudinal shaft by bevel-gears. Shaft to be $2\frac{15}{16}$ inches diameter and geared to spindle in ratio of 3 to 1. Cone and back-gear to be placed at one end of bed.

Work-table to be placed on side of main bed; to consist of a heavy bed fitted with flat ways and T-slots for bolts. Bed to be approximately 5 feet wide on top and extend 12 feet out from main bed. Should it be desirable to change dimensions or direction of location of table, the contractor will be notified of it in time. Work-table to be mounted on bed just described, to be approximately 5 feet wide and 7 feet long. To be well supplied with slots for bolting work, and provided with center-bearing for circular table.

Circular table to be approximately 6 feet in diameter and arranged to revolve on rectangular table. To be provided with divisions and index on circumference, and facilities for clamping in position. To be easily removable when desired.

Outer-bearing for long boring-bars to be provided. To consist of stiff columns of box form, and fitted with saddle adjustable vertically by screw, and provided with bushed bearing for boring-bars. Column to be provided with strong flange on bottom for bolting to table.

Workmanship and material to be first class throughout. All surfaces to be carefully scraped to good and true bearings, and all quick-running shafts to have composition bearing bushes of 90 copper and 10 tin. All shafts and screws not otherwise specified to be of good machinery steel. All gearing to be of steel or strong, close-grained iron containing 25 per cent. of cold-blast iron.

All bolts to be of refined iron, and all nuts frequently used to be case-hardened.

Counter-shafts, pulleys, hangers, wrenches, and all other appliances to complete machine ready for operation to be furnished with machine.

CLASS U.

Specifications for one Brainard's automatic gear-cutting machine.

This machine is to cut spur and bevel gears up to 40 inches diameter. To be automatic in all its movements; after being set and started, the cutter is to cut through the gear blank, returns to the starting point, it is to rotate the dividing wheel to the exact place for the next tooth, and to repeat the operation indefinitely without further attention from the operator. The machine is to be as simple as possible, and to make all the motions as nearly positive as possible.

The feed-motion to be by differential gearing, connected by hardened-steel clutches.

For the cutting of bevel-gears provision is to be made for getting the "set-over" with unfailing accuracy and certainty, obviating the usual "cut and try" system.

All motions to be quiet and without shock.

The main spindle and center spindle to be of crucible steel, the cutter-spindle to run in bronze bearings, and to be bored to receive taper arbor carrying cutter.

Both spindles to have holes through their entire length.

Workmanship must be first class, and all feeds to be adapted for steel.

A rack-cutting attachment to be furnished with the machine.

Counter-shaft, hangers, pulleys, wrenches, and all appliances to complete machine ready for operation to be furnished with machine.

CLASS V.

Specifications for one heavy milling machine, manufactured by Pedrick & Ayer.

The machine must possess vertical and angular attachment; it must be adapted for cutting racks, and spur and bevel-gears up to 40 inches diameter, for profiling or angular milling, combing or drilling at right angles to the main spindle of the machine, cutting up square stock by saws, milling of slots, arcs, or circles, dies for sheet-metal, square pieces on edge, etc. Bidders to state size of largest and smallest gears the machine will cut.

The spindle to be of steel, and the front end to run in solid self-centering boxes. Spindle to be threaded on the end to screw on large inserted tooth-mills, etc. The hole in the end of spindle to receive arbors, bushings, etc., to be about 12 inches long, 2 inches diameter at outer and 1¼ inches at inner end, so as to be practicable for heavy work.

The overhanging arm to be of hammered steel; it should move out to support cutter-arbors 26 inches from end of spindle, and should be arranged to be pushed back or moved out of the way entirely when not in use.

The knee to have a bearing of 24 by 14 inches and a vertical movement of 19½ inches. Its movement in line with the spindle to be 12 inches.

Table or platen to be 48 by 14 inches, horizontal feed 12 inches, transverse feed 32 inches. It should have three T-slots for ¾-inch bolts on top. It must be placed end for end or in line with spindle, and its feed is to operate automatically while in any position. There must be three feeds—one for table, one in line with the spindle, and one up and down feed, all reversible and automatic, with automatic stops.

All feeds to be arranged for steel-milling. Feed to be driven by a 2-inch belt and motion further conveyed through cut-gears and clutches. It must be reversible and operated by a lever of such construction as to remain in any position desired. This lever is to control all different feeds in all directions, and to work with automatic stops. All feed-gears to be of steel, cut. Dials to read in decimals. Index head to swing 16 inches. Vise to swing at any angle from 0 to 90 degrees, to have hardened-steel jaws [illegible] by 2 inches, and to open 5½ inches.

Counter-shafts to have two clutch-pulleys and to have facilities for oiling while pulleys are reversing. Hangers, drip-cups, shifter rod, and all necessary appurtenances to be furnished for counter-shaft.

With this machine will be furnished:

Index-head with back center;
Vertical and angular attachment;
Universal vise-chuck;
And such other attachments as are manufactured by Pedrick & Ayer for this machine.

CLASS W.

Specifications for two No. 3 universal grinding machines, as manufactured by Darling, Brown & Sharpe.

The bed of this machine to be supported upon two bases, forming closets for parts and fixtures.

Table, to which head and foot-stocks are clamped, to be movable about a central pivot for grinding tapers. Head to have a graduated base and to be turned at any angle; foot-stock to be fed by a screw and to have spring expansion arrangement.

The wheel-stand base to be set at any angle, and emery-wheel to be fed forward by a hand-wheel while so adjusted. Emery-wheel to be 12 inches in diameter and to be driven by two 1¼-inch belts.

Spindle-journals to be of steel, hardened and accurately ground. Emery-wheel bearings also to be hardened and ground, with boxes to compensate for wear. All working-bearing surfaces to be accurately scraped.

Counter-shaft, hangers, pulleys, wrenches, and all appliances to complete machine ready for operation to be furnished with machine.

CLASS X.

Specifications for one tool-grinding machine, as built by Wm. Sellers & Co.

This machine is to do all work required after forging to finish tools to shape.

Slide-rests, adjustable in any angle by means of graduated arcs and verniers, to have vertical, horizontal, and rotary motion, moving the tool in all directions in front of the grinding-wheel so as to grind several faces at one setting to any angle of clearance or top rake.

The machine is to be furnished with former-plates for grinding all the forms of roughing-tools found most useful in practice, and also with means to enable new former-plates to be originated from a sample tool made by hand or otherwise.

The machine is also to be provided with:

1. A chuck for circular or round-nose tools, which is also used in connection with former-plates furnished to grind curved face roughing-tools, right or left hand, and at any angle.

2. A holder to be used in grinding the side or base of the shank of tool.

3. A chuck by means of which any bent tool can be ground on all its faces, without changing its position in its chuck, with as much ease as the grinding of straight tools.

4. A chuck to hold splining or key-seating tools in the same manner.

5. A crane for lifting the wheel-cover, changing the wheel on its spindle, lifting chucks, etc.

6. Tables or diagrams, supported on a convenient holder, showing angles, position of chuck, etc., and all other data necessary for adjusting the machine to grind the different shapes and sizes of tools.

7. Counter-shaft, hangers, pulleys, wrenches, and all appliances to complete machine ready for operation.

CLASS Y.

Specifications for one emery-wheel tool-grinder No. 4, as manufactured by the Springfield Glue and Emery-wheel Company.

Emery-wheel to have 30 inches diameter and 4 inches width. Hood of wheel to *have a suitable opening with cover on back for grinding long tools.*

This machine is to be furnished with water-tanks, centrifugal pump piped, slide-rest, counter-shaft, hangers, pulleys, wrenches, and all appliances to complete machine ready for use.

CLASS Z.

Specifications for two cutter and reamer grinders No. 3, as manufactured by Darling, Brown & Sharpe.

All moving parts of this machine to be adjustable. Spindle to have two speeds; distance between centers 12 inches; machine is to grind mills or shell-reamers up to 6 inches diameter and 6 inches length.

Emery wheels used up to 7 inches diameter, either with or without water.

Counter-shaft, hangers, pulleys, wrenches, and all appliances to complete machine ready for operation to be furnished with machine.

CLASS a.

Specifications for one 1,000 *or* 1,100 *pounds single standard steam-hammer.*

Weight of drop and attached parts to be 1,000 or 1,100 pounds. Extreme stroke to be not less than 27 inches. Upper die surface to be about 13 by 9 inches, and to be set at the proper angle for drawing and finishing.

Slide-valve to be perfectly balanced, to be easily handled, and of great durability. Valve-gear to be simple, taking up its lost motion, and operating either automatically or by hand, producing every desired variation in length, position, rapidity, and force of blow. Cylinder-head to be cushioned to prevent injury to cylinder through carelessness of operator. Machine to be furnished with anvil-block and one set of plain forging-dies.

Foundation drawings to be furnished.

The machine is to be equal in design to that built by the Morgan Engineering Company, and is to be tried before leaving the works.

CLASS b.

Specifications for one Sturtevant's steel pressure-blower, No. 3.

The blower to have a diameter of outlet of 6½ inches, and to be right-hand.

Counter-shaft to be furnished with blower.

PROPOSAL.

(PLACE OF BUSINESS:) ———
(*Date:*) ———, 1889.

To the COMMANDING OFFICER,
Watervliet Arsenal, West Troy, N. Y.

SIR: In accordance with and subject to all the stipulations, conditions, and requirements of the foregoing advertisement, instructions to bidders, and specifications, which, so far as they relate to this proposal, are made a part of it, ——— propose to ——— ———, and will complete the same on or before ———, 1889.

——— make this proposal with a full knowledge of the stipulations and requirements which govern the work, and will, if it be accepted, enter into a contract with good and sufficient sureties for the faithful execution and performance of the same.

(Name of person or firm:) ——— ———
(Address:) ——— ———

GUARANTY TO THE ACCOMPANYING BID.

We, ——— ———, of ———, in the State of ——— and ——— ——— of ———, in the State of ———, hereby guaranty and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to the effect that if the bid of ——— ——— herewith accompanying, dated ———, 1889, for ——— ———, shall be accepted in whole or in part within thirty (30) days from the date of the opening of proposals, the said bidder, ——— ———, will, within ten (10) days after being notified of such acceptance, enter into a contract with the United States in accordance with the terms and conditions of ——— proposal , and will give bond with good and sufficient sureties for the faithful and proper fulfillment of the same. And in case the said bidder shall fail to enter into contract within the said ten (10) days with the proper officer of the United States, and furnish good and sufficient bond for the faithful performance of the same according to the terms of said bid and advertisement, we and each of us hereby stipulate and guaranty, and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to pay unto the United States the difference in money between the amount of the bid of the said bidder and the amount for which the proper officer of the United States may contract with another party to furnish said ——— ———, if the latter amount be in excess of the former, for the whole period covered by the proposal.

Witnesses:

——— ——— ——— ——— [SEAL.]

——— ——— ——— ——— [SEAL.]

Dated ——— ———

JUSTIFICATION OF THE GUARANTORS.

STATE OF ———,

County of ———, *ss:*

I, ——— ———, one of the guarantors named in the within guaranty, do swear that I am pecuniarily worth the sum of ——— over and above all my debts and liabilities.

[Signature of guarantor.] ——— ———

Before me,

[Signature of officer administering oath, with seal, if any.] ——— ———

STATE OF ——— ———,

County of ———, *ss:*

I, ——— ———, one of the guarantors named in the within guaranty, do swear that I am pecuniarily worth the sum of ——— over and above all my debts and liabilities.

[Signature of guarantor.] ——— ———

Before me,

[Signature of officer administering oath, with seal, if any.] ——— ———

CERTIFICATE.

I, ——— ———, do hereby certify that ——— ——— and ——— ———, the guarantors above named, are personally known to me, and that, to the best of my knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavits subscribed by him.

[Signature of certifying official, who must be a United States judge or other United States civil officer.] ——— ———

NOTE.—The certificate may be given separately as to each guarantor, and modified accordingly.

APPENDIX 24.

I.

SPECIFICATIONS FOR PNEUMATIC DYNAMITE GUNS.

(1 plate.)

Each group or battery, in all cases where the number and type of guns permit, to consist of two pneumatic dynamite-guns, including the necessary machinery to fire and handle the same, and carriages and ammunition for the same, all complete, which must be mounted in place ready for military use, at the places designated in the advertisement of December 8, 1888.

The 8-inch gun may be 70 calibers and one of the 15-inch guns 32 calibers length of bore; the remaining 15-inch guns to be 40 calibers, or of sufficient length of bore to fulfill the conditions as to range specified for the 15-inch guns of 40 calibers length of bore.

Each plant of two 15-inch guns to comprise a suitable complement of boilers, air-compressors, storage reservoirs, and hydraulic pumps to give capacity for a continuous fire of 30 rounds for the first hour and 20 rounds per hour thereafter, such capacity to be satisfactorily established by actual tests; the boilers and compressors included in such plant to be in duplicate, each to supply one-half the required capacity. For each gun which may be mounted singly the plant, as previously cited, to give capacity for a continuous fire of 20 rounds for the first hour and 10 rounds per hour thereafter.

The boilers to be of a character to pass the usual Government inspection; the compressors to be capable of giving at least the requisite number of cubic feet capacity per hour at 1,000 pounds pressure per square inch, and a proportionate volume at a pressure of 3,000 pounds per square inch, and to be so tested. The storage reservoirs and connecting pipes and valves to be subjected to a test, by hydraulic pressure, of 2,500 pounds per square inch, and the gun-valves and firing-reservoir to a similar test at 1,800 pounds per square inch.

The gun-carriages to be center-pintle, to admit of traversing through 180 degrees, or 360 degrees, if so required by the United States, and of elevating to +35 degrees; to be trained and elevated by pneumatic or hydraulic power directly under control of the gunner, and admit also of the same movements by hand power when required. The range of projectile to be controllable by variations of the pressures, elevations, or setting of valves, singly or combined. The valve or firing device to be automatic and adjustable in its opening and closing, so that the loss of air may be readily controlled. The loading apparatus to be of such character as to permit of a rate of firing at least once in three minutes for the 15-inch gun, and a projectile charged with 500 pounds of the explosive, and twice that rate of speed for the same gun and a projectile charged with 100 pounds of the explosive.

The shell to be of such character as to insure a uniform and steady flight and not break up in air or be mechanically destroyed on impact with water before detonation of the charge; to be provided with suitable electric contact fuses, which shall be safe in handling and certain of action; to admit of igniting the charge at any desired point, and also of igniting the charge at a number of points, to insure an explosion of the first order with the heavier charges; to be provided also with an electric immersion fuse, which shall be capable of ignition by immersion in salt or fresh water and admit of fully controlling the time intervening between the entrance of the shell into the water and the explosion of the charge. The shell to be charged with the best quality of explosive gelatine or an equivalent bulk of other high explosive, with proper provision made to insure safety in handling and while loading and firing the guns.

The ten unloaded shells required to be supplied with each gun must be provided with the full complement of fuses herein stipulated and be in complete order for use without other preparation than the insertion of the charge, viz: For 8-inch gun, five of each adapted to charges of 50 and 100 pounds of explosive gelatine, respectively; and for 15-inch gun, two adapted to charges of 100, five to charges of 200, and three to charges of 500 pounds of explosive gelatine, respectively.

One gun of each caliber to be selected by the Government, to be subjected to firing tests for range, accuracy of fire, and action of projectile and fuse, as follows: 8-inch gun, five rounds of shell charged with 50 and five rounds charged with 100 pounds of explosive gelatine; 15-inch gun, three rounds of shell charged with 50, eight rounds charged with 100, ten rounds charged with 200, and five rounds charged with 500 pounds of explosive gelatine. The remaining guns to be each fired six proof rounds, of which one shall be with shell containing the maximum charge of the explosive and five with a suitable iron plug—or dummy projectile—of full caliber and weight, to test the uniformity of action of the valve mechanism and other working parts, as well as to verify the rate of rapidity of firing and loading.

The proof and other trials of the guns and appurtenances, herein stipulated, must be made at the expense of the contractors, who will furnish all the charged and the dummy projectiles or iron plugs required therefor, to be delivered free of cost to the United States at Sandy Hook, N. J., or at such points as the said projectiles shall be required for the tests or proof firing.

Further stipulations are as follows:

The 8-inch gun must be capable of projecting shell charged with 100 pounds of the explosive to all ranges from 100 yards to 2,600 yards, and shell charged with 50 pounds of the explosive to all ranges from 100 yards to 3,200 yards.

The 15-inch gun of 32 calibers length of bore must be capable of projecting shell to the following ranges with the charges of explosive noted, namely:

From 100 to 1,760 yards, a shell containing 500 pounds of the explosive.
From 100 to 3,000 yards, a shell containing 200 pounds of the explosive.
From 100 to 4,000 yards, a shell containing 100 pounds of the explosive.
From 100 to 5,000 yards, a shell containing 50 pounds of the explosive.

With a 15-inch gun of 40 calibers length of bore the said ranges to be increased to the following, namely: 2,000, 3,550, 4,500, and 5,500 yards, without diminution of the stated charges; provided that if the 15-inch guns do not attain the extreme ranges stated, forfeitures shall be imposed for each yard of deficiency in range as follows: with 500 pounds charge, $5; with 200 pounds charge, $2; with 100 pounds charge, $1; with 50 pounds charge, 50 cents; and provided further that the limit of deficiency shall not exceed 10 per cent. of the stated ranges.

The accuracy of fire for all guns must not fall below that indicated in the accompanying diagram, marked A; the percentage of hits, at all ranges, in a rectangle 360 feet in length by 90 feet in width, to be at least equal to that indicated on the diagram.

One hundred per cent. of the charged shell fired for explosion on impact must show a satisfactory action of the impact fuses, and at least 80 per cent. of such shells fired into water must show a satisfactory action of the immersion fuse adjusted for either the time or the depth of immersion.

The time required to load and fire one shell containing 500 pounds of the explosive or a dummy projectile of equal weight must not exceed three minutes, and ten consecutive rounds of similar shell must be fired within forty minutes; for a shell containing 200 pounds of the explosive, or its equivalent weight, one in two minutes and ten consecutive rounds in twenty-seven minutes; for a shell containing smaller charges of the explosive, or its equivalent weight, one in one and one-half minutes and ten consecutive rounds in 20 minutes.

The time of maneuvering from extreme depression to extreme elevation, or the reverse, not to exceed 15 seconds, and the time of complete traversing not to exceed 30 seconds; provided that in case these rates of speed are not attained, a forfeiture of $5 shall be imposed for each additional second of time required for elevating (or depressing) and traversing in excess of the times stated; and provided further that the limit of excess in time to be allowed shall be 20 seconds.

The time required for discharging twenty consecutive rounds with the heaviest charges from any single gun must not exceed one hour and that required for discharging thirty consecutive rounds must not exceed two hours.

All dimensions to be subject to such slight changes, not materially affecting the results to be attained, as the United States may agree to make as the work progresses.

All materials and workmanship are to be of good quality, the valves and joints to be air tight under working pressures, and all parts of the guns and machinery to be efficient in operation. The work shall be open to inspection by the Government at all stages.

II.

SPECIFICATIONS FOR PNEUMATIC DYNAMITE GUNS.

1. The three pneumatic dynamite guns of 15-inch caliber, including the necessary machinery to fire and handle the same, ammunition and carriages for the same, must be placed and mounted ready for military use at the place designated in the advertisement of April 23, 1889.

2. The guns shall be 40 calibers length of bore, to be fully equal in quality of material, finish of parts, and performance, and subject to like tests as guns of the same caliber and length of bore now being procured under contract. The gun carriages and machinery to be mounted upon secure and adequate foundations which shall be sufficient to withstand without any derangement a continuous fire of the heaviest projectiles to be used in the guns.

3. The plant of the three guns to comprise a suitable complement of boilers, air-compressors, storage reservoirs, and hydraulic pumps to give capacity for a continuous fire of forty-five rounds for the first hour and thirty rounds per hour thereafter, such capacity to be satisfactorily established by actual tests; the boilers and compressors included in such plant to be in duplicate, each to supply one-half the required capacity. The connections to be so arranged as to give capacity for a continuous fire of thirty rounds for the first hour and twenty rounds per hour thereafter if only two of the guns be used, and twenty rounds for the first hour and ten rounds per hour thereafter if but one of the guns be used.

4. The boilers to be of a character to pass the usual Government inspection; the compressors to be capable of giving at least the requisite number of cubic feet capacity per hour at 1,000 pounds pressure per square inch and a proportionate volume at a pressure of 3,000 pounds per square inch, and to be so tested. The storage reservoirs and connecting pipes and valves to be subjected to a test, by hydraulic pressure, of 2,500 pounds per square inch, and the gun-valves and firing reservoir to a similar test of 1,800 pounds per square inch.

5. The gun carriages to be center-pintle, to admit of traversing through 180 degrees, or 360 degrees if so required by the United States, and of elevating to +35 degrees; to be trained and elevated by pneumatic or hydraulic power directly under control of the gunner, and admit also of the same movements by hand power when required. The range of projectile to be controllable by variations of the pressures, elevations, setting of valves, singly or combined. The valve or firing device to be automatic and adjustable in its opening and closing, so that the loss of air may be readily controlled. The breech mechanism to be so arranged that the gun can not be discharged unless the breech is completely closed and locked. The loading apparatus to be of such character as to permit of a rate of firing at least once in three minutes for each gun, and a projectile charged with 500 pounds of the explosive and twice that rate of speed for a projectile charged with 100 pounds of the explosive.

6. The shell to be of such character as to insure a uniform and steady flight and not break up in air or be mechanically destroyed on impact with water before detonation of the charge; to be provided with suitable electric contact fuses, which shall be safe in handling and certain of action; to admit of igniting the charge at any desired point, and also of igniting the charge at a number of points, to insure an explosion of the first order with the heavier charges; to be provided also with an electric immersion fuse, which shall be capable of ignition by immersion in salt or fresh water and admit of fully controlling the time intervening between the entrance of the shell into the water and the explosion of the charge. The shell to be charged with the best quality of explosive gelatine or an equivalent bulk of other high explosive, with proper provision made to insure safety in handling and while loading and firing the guns.

7. The unloaded shell required to be supplied must be provided with the full complement of fuses herein stipulated and be in complete order for use without other preparation than the insertion of the charge.

8. Each gun when finally mounted to be fired six proof rounds, of which one shall be with shell containing the maximum charge of the explosive and five with a suitable iron plug—or dummy projectile—of full caliber and weight, to test the uniformity of action of the valve mechanism and other working parts, as well as to verify the rate of rapidity of firing and loading; and one or all of the guns, as the Department may select, to be subjected to firing tests for range, accuracy of fire, and action of projectile and fuse, for which purpose the contractor must supply not less than eight projectiles adapted to and containing a charge of 100 pounds of explosive gelatine.

9. The proof and other trials of the guns and appurtenances, herein stipulated, must be made at the expense of the contractors, who will furnish all the charged and the dummy projectiles or iron plugs required therefor, to be delivered free of cost to the United States at Fort Winfield Scott, Cal.

10. It is further stipulated that the guns shall be fully equal in range and accuracy to those of the same caliber and length of bore now being procured under contract; provided, therefore, it be fully established to the satisfaction of the Department that the three guns herein specified are in all material respects equal in efficiency to the said guns now under contract; then, so far as may be necessary, in the absence of direct tests, the performance of these guns shall be judged by that of the said guns now under contract.

11. Each 15-inch gun of 40 calibers length of bore must be capable of projecting shell to the following ranges with the charges of explosive noted, namely:

From 100 to 2,000 yards, a shell containing 500 pounds of the explosive.
From 100 to 3,550 yards, a shell containing 200 pounds of the explosive.
From 100 to 4,500 yards, a shell containing 100 pounds of the explosive.
From 100 to 5,000 yards, a shell containing 50 pounds of the explosive.

Provided that if the guns do not attain the extreme ranges stated, forfeitures shall be imposed for each yard of deficiency in range as follows: with 500 pounds charge, $5; with 200 pounds charge, $2; with 100 pounds charge, $1; with 50 pounds charge, 50 cents; and provided further that the limit of deficiency shall not exceed 10 per cent. of the stated ranges.

12. The accuracy of fire for all guns must not fall below that indicated in the accompanying diagram marked A; the percentage of hits, at all ranges, in a rectangle 360 feet in length by 90 feet in width, to be at least equal to that indicated on the diagram.

13. Seventy-five per cent. of the charged shell fired for explosion on impact must show a satisfactory action of the impact fuses, and at least 75 per cent. of such shells fired into water must show a satisfactory action of the immersion fuse adjusted for either the time or the depth of immersion.

14. The time required to load and fire one shell containing 500 pounds of the explosive or a dummy projectile of equal weight must not exceed three minutes, and ten consecutive rounds of similar shell must be fired within forty minutes; for a shell containing 200 pounds of the explosive, or its equivalent weight, one in two minutes and ten consecutive rounds in twenty-seven minutes; for a shell containing smaller charges of the explosive, or its equivalent weight, one in one and one-half minutes and ten consecutive rounds in twenty minutes.

15. The time of maneuvering from extreme depression to extreme elevation, or the reverse, not to exceed fifteen seconds, and the time of complete traversing not to exceed thirty seconds; provided that in case these rates of speed are not attained a forfeiture of $25 shall be imposed for each additional second of time required for elevating (or depressing) and traversing in excess of the time stated; and provided further that the limit of excess in time to be allowed shall be twenty seconds.

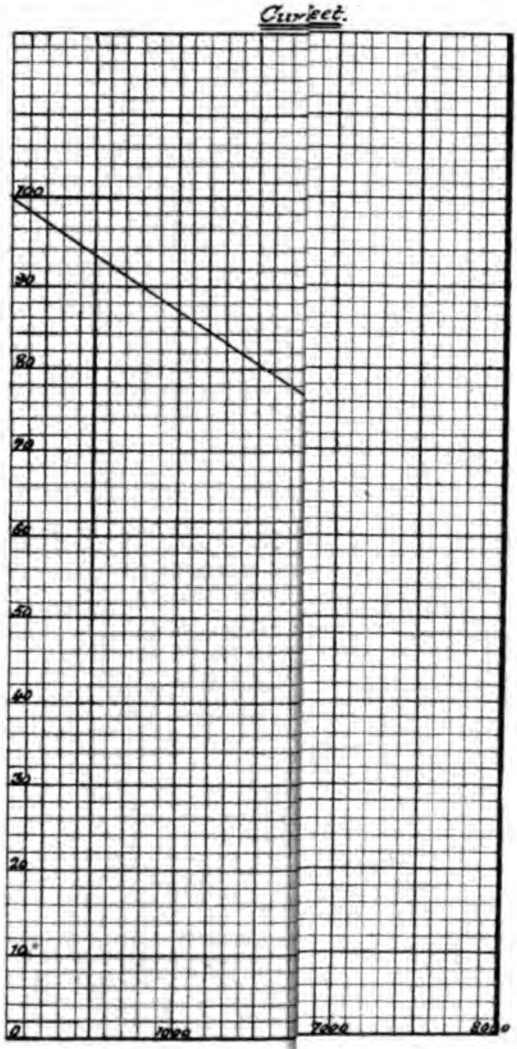
16. The time required for discharging twenty consecutive rounds with the heaviest charges from any single gun must not exceed one hour, and that required for discharging thirty consecutive rounds must not exceed two hours.

17. All dimensions to be subject to such slight changes, not materially affecting the results to be attained, as the United States may agree to make as the work progresses.

18. All materials and workmanship are to be of good quality, the valves and joints to be air tight under working pressures, and all parts of the guns and machinery to be efficient in operation. The work shall be open to inspection by the Government at all stages.

Ordnance Office, U.S.R., Dec. 4th 78

PLATE I.



Appendix 24, 1889.

APPENDIX 25.

PROPOSALS FOR 10-INCH DISAPPEARING PNEUMATIC GUN-CARRIAGE.

ORDNANCE OFFICE,
Washington, August 5, 1889.

Sealed proposals, in duplicate, will be received at this office until 3 o'clock p. m. on Thursday, September 5, 1889, at which time and place they will be publicly opened, for supplying the Ordnance Department, U. S. Army, with one disappearing gun-carriage, maneuvered by power, for a 10-inch breech-loading rifle, in accordance with the plans of the Pneumatic Gun Carriage and Power Company, and to conform to specifications to be had at this office. Bidders will state the price for the carriage delivered and mounted complete and ready for test at the Ordnance Proving Ground, Sandy Hook, N. J., and the time in which the delivery will be completed. Blank forms upon which proposals must be made can be had upon application. Copies of the advertisement and specifications, and of the drawings now filed in this office, must accompany and form part of proposals. The Department reserves the right to waive informalities and to reject any or all bids. Proposals should be marked "Proposals for 10-inch disappearing gun-carriage," and be addressed to "Captain C. S. Smith, Acting Chief of Ordnance, U. S. Army, Washington, D. C."

SPECIFICATIONS FOR 10-INCH DISAPPEARING PNEUMATIC GUN-CARRIAGE.

The 10-inch disappearing pneumatic gun-carriage for which proposals are invited by advertisement dated Ordnance Office, Washington, August 5, 1889, shall be in general design like the three drawings furnished by the Pneumatic Gun-Carriage and Power Company to the Board of Ordnance and Fortification and now filed in the Ordnance Office, War Department.

The price which may be agreed upon for the carriage, to be paid upon the acceptance of the same by the United States, shall include all expenses incident to the building of the carriage and its mounting, complete, ready for service, except the actual labor and material for the masonry part of the foundation, the design for which foundation shall be furnished by and at the expense of the party furnishing the carriage, and the responsibility for its sufficiency shall rest with the same.

The carriage must be presented ready for test within a year from the time of making the contract.

In the construction of this carriage the following conditions must be fulfilled, viz:

1. The carriage shall be suited to a 10-inch B. L. rifle, steel, of 32 calibers length of bore, firing a charge of 250 pounds of powder, or a sufficient charge, with a projectile weighing 575 pounds, to give a velocity of about 1,975 feet.

2. The carriage shall permit of motion for firing through a horizontal angle of 120 degrees, and for loading shall admit of being traversed to a position parallel to and in the close vicinity of the parapet.

3. When in a loading position at right angles to the parapet, no part of the gun or carriage shall extend above a plane passed through the interior crest and sloping to the rear at an angle of 7 degrees with the horizon. The interior crest as here mentioned will be understood to be represented by a horizontal line 145 inches above the plane of the lower surface of the pintle-plate of gun-carriage; and the plane (vertical) of the breast height wall will be considered as parallel to and 5 feet in rear of this horizontal line.

4. The gun when in position for firing shall permit of a depression of 5 degrees and of an elevation of 20 degrees, and the muzzle shall project not less than 5 feet beyond the breast height wall.

5. When in position for loading the axis of the gun shall not make with the horizontal an angle greater than 5 degrees, and in this position it shall be practicable to regulate accurately the elevation that may be desired for firing.

6. For all charges between a minimum of 170 pounds of the powder to be adopted

for the gun, or such weight of other powder as will give the same velocity, and the maximum charge indicated in paragraph 1, and for all elevations used, the gun shall always return to the same position of recoil for loading.

7. The construction shall be such that the piece may be raised to the firing position, its recoil controlled, the carriage traversed, and the charge raised and loaded in the gun by compressed-air power.

8. A hand pump capable of charging the recoil cylinders shall be furnished in order that steam power can be dispensed with, and means shall be provided for traversing, elevating, and loading the piece by hand power.

9. There shall be a differential air-pump connected with the recoil cylinders to make good any slight leakages, in order that the carriage may be tested for continuous firings disconnected from hand or steam pumps.

10. With the carriage shall be furnished all the necessary metal parts, including connecting pipes, bed-plates, circles, and holding-down bolts; also such parts as may be necessary to adapt the gun to the carriage. The compressing engine, boiler, compressors, and accumulator will not be required, it being assumed that those now at the Ordnance Proving Ground at Sandy Hook will be sufficient.

11. The party supplying the carriage will be required to lay the bed plates and all pipe connections, and to set up the carriage complete in all respects, ready for service; the Government shall only be required to build the masonry foundation, which will be done according to working drawings to be furnished with the carriage.

12. The weight of the carriage should be as light as practicable, consistent with the development of the principles involved and the requisite strength of the system.

13. The material used in the construction shall be principally steel, of domestic manufacture. The ultimate strength of the steel used in the construction of the carriage shall not be less than 50,000 pounds, with 20 per cent. elongation in a specimen of the form adopted by the Ordnance Department, 2 inches between shoulders and .5 inch in diameter.

The parties furnishing the carriage and appurtenances shall be solely responsible for such plans as they may adopt and use in the construction. The work shall at all stages be open to official inspection, and the contractors for the work shall at all times furnish full facilities for its inspection by the Government; they shall also furnish any assistance that may be required in determining the quality of the materials or workmanship used or intended for use in the construction of the carriage and its appurtenances, and generally such information, including drawings, in regard thereto and manner of using the same as may be required. The materials and workmanship shall be of the best quality and finish, and the United States may peremptorily reject any unfit material or workmanship or forbid the use thereof. The tests of material intended for use in the carriage and its appurtenances shall be made at the expense of the contractors. The specimens for tests of the principal members of the structure will be taken directly from the parts themselves. In the case of castings these specimens must be cut either from coupons to be cast thereon or from the sinking heads, where such heads are of sufficient size. A copy of the records of tests of any material which may be tested other than under the direct supervision of a Government inspector, certified by the signature of the engineer of the tests, must be furnished to the Government.

When the carriage shall have been set up ready for use the gun shall be mounted thereon by the Government, and the following firing tests shall be made under the supervision of the Board of Ordnance and Fortification:

1. Ten preliminary rounds with such charges as may be suited to test the working and adjustment of the several parts of the carriage.

2. Ten rounds with full-service charges, as may be directed by the board.

3. Ten rounds with full-service charges as rapidly as the gun can be served.

If the conditions stipulated be fulfilled and the working of the carriage, including the raising, the lowering, the traversing, the elevating, and the loading be satisfactory to the board, the carriage shall be accepted.

If failures to meet these requirements shall occur, further tests may be made sufficient in number to reasonably demonstrate the capabilities of the carriage, the number of such additional tests to be determined by the board. If then deemed satisfactory the carriage may be accepted.

The expense of the above-indicated tests and the ammunition for such experimental firing as may be deemed necessary before the carriage is turned over for official test shall be borne by the United States.

In the manufacture of this carriage payments will be made by the United States on the regular certificates of inspection and receipt used by the Ordnance Department, in six equal installments, as the work progresses, with a reservation of 10 per cent. from each installment, provided that the parties to whom the contract may be awarded shall give an indemnity bond therefor satisfactory to the Secretary of War. The last payment shall not be made until the contract shall have been fully performed by or on the part of the contractors and the carriage and appurtenances shall have been accepted by the United States.

APPENDIX 26.

REPORT OF THE PRINCIPAL OPERATIONS AT THE ROCK ISLAND ARSENAL, ILLINOIS, DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

(12 plates.)

PERMANENT SHAFTING.

The work done under this head during the year was the following:

One thousand six hundred cubic yards of earth and rock excavated; 100,000 brick laid in tunnels between shops; 4,160 square feet of concrete floor laid; 400 cubic yards masonry laid; 17 cubic yards stone piers for pillow blocks cut and set.

The necessary pillow blocks, journals, couplings, etc., were made in the arsenal shops, and 24,000 pounds steel shafting purchased and put in place.

The work on the underground shafting is now completed from shop A to west wall of shop G.

The appropriation for the work was inadequate to extend it the whole length of the arsenal row of shops, and the amount required to finish it is included in the estimate for the next fiscal year.

NEW OFFICE.

The granite steps and platforms on outside of building were purchased and set in place.

A concrete floor was laid in basement and its walls and ceilings plastered.

The fire-proof vaults on first and second floors were fitted up for use.

All plumbing and arrangements for connecting the building with elevated tank and reservoir completed.

A gasoline-gas machine for lighting the offices was purchased.

SHOP K.

This building was commenced in July, 1881. It is the last of the shops embraced in the plans for both the armory and arsenal. The work done during the year was as follows:

Stone-work.

Two hundred and thirty-three cubic yards of area wall laid; 2,710 linear feet of coping and flagging cut and laid in area wall.

Steps and platforms on inside of basement cut and set.

Wood-work.

Eighteen sets of hatchway covers and bars and sixteen doors were made and fitted.

Painting.

The iron columns, girders, and floor-beams, and the window-frames were painted two coats.

The balance of the appropriation for this building is inadequate to complete it, and the amount required for this purpose is included in my estimate for the next fiscal year.

MACHINERY AND SHOP FIXTURES.

The small appropriation under this head has been mainly expended in overhauling and fitting up the lines of shafting in the arsenal shops, in casting and fitting hangers, pulleys, etc., for use in the new shops, and in the purchase of needed machines.

STORE-HOUSE K.

The principal work done on this building during the year was as follows:

Stone-work.

Five hundred cubic yards stone cut for the third story; 458 cubic yards stone set in second story; 120,000 bricks laid in first story.

The stone required to complete the building is all on the arsenal grounds, and the greater part of it cut ready for laying in the walls, and the building will be ready for the roof in the fall.

Iron-work.

All the iron-work for basement and first story has been completed, and that for the second story nearly completed.

Wood-work.

The yellow-pine floor girders and joists of the first and second stories have been laid, and the window frames for first and second stories nearly completed.

A deviation from the plans of store-house A in the construction of the floors has been deemed necessary on account of strength. The ceilings, instead of being plastered, will in this building be finished in wood. All these changes are fully shown on Plates V, VI, VII, and VIII.

GENERAL CARE, PRESERVATION, AND IMPROVEMENTS.

In consequence of the totally insufficient appropriation under this head, it was absolutely necessary that nearly all of it should be expended in the care and preservation of buildings, shores of the island, and bridges. Much necessary work under this head had to be left undone, especially the repainting of buildings for their preservation (the estimated cost of which is $10,000) and no progress of importance could be made in the way of carrying on the needed improvements of grounds, roads, etc.

RECONSTRUCTION OF THE WATER-POWER DAM.

The temporary dam or bulkhead above the ruins of the old dam has been built in a good and substantial manner and it is believed will be able to withstand the pressure of the river at all stages of water until the permanent dam is completed.

REPAIRS OF DYKES AND EMBANKMENTS OF THE WATER-POWER POOL.

A strong earth dyke with riprapped face has been built around the head of the island from a point O at Benham's Dam to M at the Moline bridge, to prevent overflow, and the work of repairing and strengthening the other dykes and embankments of the pool, which were damaged by the flood of 1888, was in progress at the close of the year.

ROCK ISLAND BRIDGE.

An inspection of this bridge last May revealed the fact that many of the timbers supporting the upper dock were decayed to such an extent as to render the bridge dangerous for railroad travel.

As the appropriation for care and preservation was only sufficient for the ordinary expenses of the bridge, it would not permit me to undertake any extensive repairs, and I could only replace the worst of the decayed timbers by sound ones, to secure the safety of the bridge.

The work was done by the Chicago, Rock Island and Pacific Railway Company under my direction, and one-half the expense charged to that company under their guaranty executed to the United States under the acts of Congress providing for the construction of the bridge. The replacing of these timbers was only a temporary expedient to insure safety, but the bridge can not now be said to be in a safe condition for railway travel. To render it so would require the renewal of nearly all of the timbers in the upper deck, and the expense would far exceed the annual appropriation for care and preservation.

It is believed it would result in ultimate economy to renew the entire upper deck in iron, the cost of which would be $50,000, and an estimate for this purpose has been submitted.

As it is of vital importance that this iron deck be put up with the least possible delay, to guard against accident, I respectfully request that this matter be brought to the attention of Congress as early as practicable, and that that body be urged to make the appropriation available from the passage of the act making it.

The plans for the renewal of the upper deck in iron have the approval of the Chicago, Rock Island and Pacific Railway Company, and that company will pay one-half the cost of the work, in accordance with the terms of their guaranty above referred to.

The following is an abstract of the travel over the bridge during the year.

Passing north.

Engines with trains	8,340
Engines without trains	354
Total engines	8,694
Passenger cars	15,111
Freight cars	122,053
Foot passengers	262,538
Teams	183,401
Steam-boats	1,347
Barges	71

Passing south.

Engines with trains	8,034
Engines without trains	557
Total engines	8,591
Passenger cars	15,095
Freight cars	116,938
Foot passengers	264,978
Teams	181,484
Steam-boats	1,358
Barges	55
Rafts	837

STREET RAILWAY.

The act of Congress approved March 3, 1885, authorized and empowered the Secretary of War to permit the establishment of a horse railway over the bridges and islands.

The company which had the original franchise was unable to comply with the requirements of the War Department and disposed of its interest to a corporation known as the Davenport and Rock Island Street Railway Company. This latter company secured the required right of way in Rock Island and Davenport, and deposited with me a sufficient sum of money to commence the work.

The work was taken in hand in December and was prosecuted as fast as the material could be supplied until it was completed. The road is constructed as follows:

The ties, of sound white oak, are bedded in concrete of at least 6 inches in thickness, flush with their upper surface; the concrete is 1 part Portland cement, 2 parts pit sand, and 5 parts limestone rock broken to a size not to exceed 2½ inches and free from dirt. The sand and cement were thoroughly mixed dry, the broken rock thoroughly sprinkled, and the whole then thoroughly mixed, enough water being used to make a thick paste.

When the temperature was below the freezing point 1 pound of rock salt was used to every 18 gallons of water, and an addition of 1 ounce of the salt was made for each degree below 32°.

The Johnston rail is used, and is supported by a chair 4¾ inches high, spiked to the ties. The top of the rail is a little more than 8 inches above the top of the tie. The ties are placed 5 feet apart for straight track and 3 feet apart on the curves.

A week or more was allowed for the concrete to set (it being covered in the mean time to exclude frost), when it was covered with about 3 inches of dry sand, upon which the pavement of granite blocks is laid.

The space under and in the pocket of the rail is packed with sand and gravel. The courses of the pavement are continuous transversely, but broken longitudinally. The joints are filled with clean, dry, and fine hot gravel, and then cemented by asphalt cement heated to 360° Fahr. The tracks are 4 feet 10 inches apart, and the granite pavement extends for 2 feet on each side of these, thus forming a handsome and permanent roadway 18 feet 3 inches wide along Fort Armstrong avenue and over the approaches to the bridges.

On the bridges flat rails are used, between them is laid a transverse planking of 2-inch oak, beveled at the ends, and the spaces between and outside of the tracks are on the Rock Island bridge covered longitudinally with 2-inch ash.

Iron plates are laid between the rails for wagons, the tread of which *is wider than* the standard gauge.

The total cost of this road was $30,979.30. Up to the close of the fiscal year no cars had crossed the bridge.

ORDNANCE AND ORDNANCE STORES.

The ordnance stores manufactured during the year have been reported in the monthly statements and the quarterly abstracts of fabrication.

On February 28, 1889, the Chief of Ordnance desired that a tent knapsack be made at the arsenal, and Capt. A. L. Varney was detailed for this work. He submitted a sample tent and his report is appended hereto and marked Appendix A. On May 24 I submitted a device similar to Captain Varney's, but believed to possess many advantages over the latter. A description of this device is appended hereto and marked Appendix B, and figured on Plates XI and XII accompanying this report.

The main feature of my tent knapsack is that it permits the use of the rifle as a tent pole and prevents any injurious strain from such use from coming on the arm; while at the same time a regulation tent-pole, or one improvised from time to time as required, can be used as with the old-style shelter tent. The tent can be used with the gun as a tent-pole or without it, using such tent-pole as circumstances may warrant; but if the arm is so used no injury can come to it from such use.

The gun-sling pattern, 1887, is shown on Plate IX, and the method of mounting the sling on the rifle and of loosening it for skirmish firing is given in Appendix C.

On February 13, 1889, the Chief of Ordnance directed that 1,000 spurs for mounted officers be made at this arsenal. The spur is shown on Plate X. It is made of gun metal, polished, with curved shank holding a sharp steel rowel three-fourths of an inch in diameter; solid button on each side to hold chain and leather strap. Chain goes under the foot and is of the same metal as spur, curb pattern, with one extra link at each end for purpose of adjusting to size. Strap goes over foot, of black bridle leather, cut with double curve and billet point. Tab of same material with flat buckle, with center bar and tongue of same metal as the spur. Size of buckle five-eighths by five-eighths inch, inside measure.

LIST OF DRAWINGS ACCOMPANYING THIS ANNUAL REPORT.

Plate I. Map of Rock Island Arsenal.
Plate II. Map of lower end of island, showing bridge connections with the adjacent shores, and the lines of street railway tracks from Davenport, Iowa, to Rock Island, Ill.
Plate III. Profiles of Fort Armstrong avenue and causeway, showing details of construction of street-railway track and granite paving.
Plate IV. Plan of temporary bulkhead in water-power pool, showing also details of construction.
Plate V.
Plate VI. } Store-house K, showing changes made from plans of store-house A, in the floor construction.
Plate VII.
Plate VIII.
Plate IX. Gun-sling, model 1887.
Plate X. Spurs for mounted officers.
Plate XI. Major McGinness's tent knapsack and shelter tent.
Plate XII. Major McGinness's tent knapsack folded to be slung on the back.

Respectfully submitted.

JNO. R. MCGINNESS,
Major, Ordnance Dept., U. S. Army, Commanding.

ROCK ISLAND ARSENAL, *August* 30, 1889.

APPENDIX A.

ROCK ISLAND ARSENAL, *March* 23, 1889.

COMMANDING OFFICER ROCK ISLAND ARSENAL:

SIR: I have the honor to state that, except possible objection on account of its unsightly appearance, the "pack" submitted herewith conforms, as nearly as I can make it, with the views of the major-general commanding, as expressed in the eleventh indorsement on the letter inclosing this report.

The "pack" contains all the articles required to be carried on the person in the ordnance blanket bag (see circular accompanying these papers, dated Headquarters Department of the Platte, March 30, 1887), viz, one dark-blue flannel shirt and one knit undershirt (in one small canvas valise), one pair drawers and two pairs stockings (in a second valise), one pair campaign shoes and forty cartridges (in a third valise), one overcoat, one blanket, and one-half a shelter-tent, the latter forming an envelope for the whole "kit." The small valises lie end to end in the center of the roll, and serve to prevent the small clothes from being scattered in the dirt when the pack is broken for the purpose of pitching the tent, and, being marked with the regiment, company, and number of the owner, they may be left in store or transported in wagons whenever it is desirable to reduce the weight of the pack. Leather straps have been provided to hold the roll in shape and to sling it on the shoulder. The weight of the roll and accessions is 29 pounds 1 ounce, made up as follows: Blanket, 5 pounds 4½ ounces; overcoat, 6 pounds 11½ ounces; half-tent with guy lines, 3 pounds 14 ounces; ammunition (40 rounds) 4 pounds 9¼ ounces; pair shoes, 2 pounds 8¼ ounces; pair drawers, 13 ounces; undershirt, 1 pound 7 ounces; blue shirt, 1 pound; 2 pairs stockings, 8 ounces; 3 valises, 15 ounces; carrying-strap, complete, 1 pound 2¼ ounces.

The considerations which induce me to submit this form of "pack" are: First, it is more consistent with the proposition that a soldier's load should consist of a maximum of articles that will contribute to his efficiency and comfort, and a minimum of harness to carry it; second, this method of carrying such articles, adopted spontaneously and almost unanimously by the soldiers of widely separated armies during the late war, is likely to be much superior to any of the devices proposed by interested theorists or men without requisite experience.

No tent-poles or pins have been provided. They can be readily obtained by the use of the hunting knife in a country where saplings and bushes grow; otherwise pins should be carried and the rifles of two tent-mates used for poles, the height of the tent having been fixed with this view. Objection may be raised to such use of the rifle on the score that it might be suddenly wanted as a weapon while so employed or that it might be injured by the weather, but the tompion and muzzle cover (attached to the guy line) will keep the rain out of the barrel, and the latter, if turned toward the interior of the tent, will not come in contact with wet canvas. It seems, therefore, that the piece would be as well protected and as accessible in this position as it would be lying on the ground under the blankets. Every half-tent is intended to be exactly like every other, so that perfect interchangeability is secured. Each tent covers a ground space of 5 by 6 feet, giving ample room for two men. The end of the tent is an equilateral triangle, which gives a symmetrical shape to the half-tent and a good slope for shedding rain. The material is 8-ounce duck, making a warm and durable tent without excessive weight. The clothing used to form this pack has been borrowed from Capt. Jas. Rockwell, jr., Ordnance Department, post quartermaster, and if forwarded to the Chief of Ordnance (which I would respectfully recommend), should be returned, or receipts furnished to Captain Rockwell, to cover the transfer. I also submit herewith a leather case designed to contain one paper package (20 rounds) of ammunition, with loops for carrying it on the belt. The loops are large enough to pass over the Mill's cartridge belt when filled. It is merely a suggested substitute for the usual way of carrying extra ammunition in the pack.

Very respectfully, your obedient servant,

A. L. VARNEY,
Captain, Ordnance Dept., U. S. A.

APPENDIX B.

ROCK ISLAND ARSENAL, *May* 24, 1889.

The CHIEF OF ORDNANCE, *U. S. Army*,
Washington, D. C.:

SIR: On February 28, 1889, the Chief of Ordnance directed me to carry out the views of Maj. Gen. J. M. Schofield, commanding the Army, relative to combining shelter tent and knapsack, as embodied in the following indorsement, viz:

"HEADQUARTERS ARMY OF THE UNITED STATES,
"*February* 25, 1889.

"Desired by the major-general commanding that reference be made to the Chief of Ordnance, with the following remarks: In the accompanying papers, three classes of knapsack, the 'ordnance blanket bag,' 'Colonel Merriand's knapsack,' and 'Dr. Parker's clothing case,' are considered, but no one of them fulfills all the requisites that I deem most necessary in this article of equipment. The soldier must carry in the field extra ammunition, his blanket, half a shelter tent, and some of his clothing, which latter, experience has shown, will vary in amount according to the attendant conditions; that is, whether the march is forced or at a normal rate or whether an action is pending. Hence the load both in weight and bulk will change from time to time. This varying bulk then suggests the desirability of corresponding adjustments in the dimensions of the knapsack intended to carry it, which, if it could be combined with a double use of any portion of the equipment, would result in a marked diminution of the soldier's load. If the shelter tent could be so arranged that on the march it would answer the purpose of a knapsack, permitting of adjustment according to bulk to be carried, with proper straps for its support, and yet on coming into camp be opened out and revert to its use as a tent, a great improvement would be effected in the equipment of our Army. Therefore the reference, in the hope that the Ordnance Department will be able to devise some method of using the shelter tent as a knapsack, which will fulfill these different requirements of the service.

"THOMAS M. VINCENT,
"*Assistant Adjutant-General.*"

On March 23, 1889, a shelter-tent pack and harness to carry it, containing certain articles of the soldier's clothing, weighing 29 pounds 1 ounce, was forwarded, which it was believed at the time conformed in the closest degree to the views of the major-general commanding the Army. I forward to-day by express a tent knapsack and drawings, which is believed to be an improvement on the former one, but following out the same general lines. By reducing the size of the tent to that of the old shelter-tent and dispensing with all harness, the weight of the pack or knapsack, although containing the same number and kind of articles, has been brought down to 26 pounds 7 ounces, and it is believed to conform to the ideas of the major-general commanding as closely as it is possible to make it, for the following reasons:

First. It combines tent and knapsack.

Second. It permits of a reduction of weight and bulk by dispensing with some of the clothing when necessary for forced marches, etc.

Third. It admits of varying adjustment of knapsack as amount of clothing and consequent bulk are reduced. By untying the ends, the small valises may be withdrawn, a change of clothing effected, and the valises replaced without unpacking the roll. These valises should be marked on the end with company and regiment and individual number of owner.

Fourth. It allows of a double use of tent.

Fifth. It allows of a double use of the musket.

Sixth. It allows of a double use of the small valises, containing the soldier's underclothing (as pillows).

Seventh. While permitting the use of the musket as a tent-pole, it will be observed that no cross-strains are allowed to come on the arm, and no strain of any kind can come on the barrel. The slight vertical component coming through the guy-ropes is transmitted downward through the stock alone. The cross-strains coming through the guy-ropes neutralize each other through the canvas-ridge of the tent when the guys are taut. The socket-holes rest on the upper bands, and can not pass over them. Thus the weight of the tent-end guy-rope strains is all transmitted vertically through the stock alone to the ground, and can not injure the arm, not being enough to harm the stock in the slightest degree.

Eighth. It conforms to the kind of knapsack that experience has shown the soldier prefers.

Ninth. It affords a water-proof protection to the rifle. The sockets are water-proof, and, as they are the only part of the tent coming in contact with the arm, it is completely protected from the weather.

Tenth. It compels the soldier to take the same care of his arm, to protect it from the weather, that he does of himself. This is a most important and desirable feature of the device, as it compels him to afford his weapon shelter *before* he can get it for himself.

Eleventh. It diminishes the load by dispensing with the weight of tent-poles, but these can be improvised at any time whenever necessary, as, for instance, when the man has to go on guard, scouts, etc.

Twelfth. It allows a free use of the man's arms when on the march and does not bind or impede the muscles of the chest or shoulders. It can be folded as represented in drawing, for parade and inspection purposes, like the ordinary knapsack. To do this the guy-rope is used to tie up the pack in the way prescribed. A special carrying harness is provided, composed of two adjustable straps to embrace the knapsack, and two sling straps, also adjustable, through which the soldier passes his arms. I do not think that any knapsack can be carried with any degree of comfort for long distances, but as it presents a better appearance for parades and reviews provision is made for this use of the tent knapsack.

LIST OF ARTICLES.

The following are the weights of the knapsack or pack and contents.

	Lbs.	Oz.	Dr.
1 half tent with guy lines	3	7	4
1 blanket	5	3	8
1 overcoat and cape	5	14	10
40 rounds of cartridges	4	8	8
1 pair shoes	2	11	12
Valise B:			
1 pair drawers	0	14	1
1 undershirt	1	2	6
Valise A:			
1 blue shirt	1	1	8
2 pairs socks	0	8	3
2 valises, small	0	9	6
1 valise, large	0	5	14
Total	26	7	

DIRECTIONS FOR PACKING.

Turn in triangular end of tent so as to leave tent 3 inches longer on each end than the long way of the blanket; fold blanket once the long way and lay on tent along ridge edge and even with it: lay overcoat on left end, collar to left, cape detached following next in length, top of cape to left; turn ends over blanket, place valise containing blue shirt and socks at left end, the other valise, containing shirt and drawers, at right end; one shoe, containing a package of cartridges, next to each valise, heel toward valise; one empty valise in middle (to use for shoes and cartridges if desirable).

Roll pack together closely and tie with cords attached to garments. Bend roll and tie ends together securely with guy-rope. The guy-rope has a knot at one end, the other is wound with twine to prevent ravelling; make a half hitch at the knotted end, pass free end through so as to form a loop, slip loop over both ends of roll 3 inches from the end, draw tight and give three turns of rope around the ends; hold the rope tight with left hand, pass free end down through the inside and bring it around between the two ends of roll; put free end up under the part held by the left hand, draw tight, and take two half hitches in rope at this part.

COLOR OF TENT.

What is known as a "dead grass" color is preferred for this tent, for the reason that it will not soil or become unsightly as soon as a clear white. The color that should be used may be seen in the strip of webbing running along the ridge of the tent. The desired colored duck could not be procured here. This color will present a less conspicuous mark to the enemy, both on the march and in camp.

SIZE OF TENT.

The tent covers a space of 5 by 6 feet.

HOW TO SET UP THE TENT.

Calling one half A and the other B, we begin by buttoning the two halves together along the ridge. Insert the socket of A through the socket-hole in B; this will bring the socket of B over the socket-hole of A. Hook the triangular ends in the rings intended for them, spread the ends apart so as to mark the place for the end corner pins, drive these pins, drive the guy pins at a distance from the tent equal to its height. Insert the guy-ropes from underneath. Insert the muskets in the sockets, barrels turned inwards, fasten guy-ropes, giving each a strain of about 8 or 10 pounds. Fasten tent to corner pins, and then drive the other pins and tie tent to them.

The tent can be made to embrace the soldier's belongings in the regular knapsack or prismatic form by folding it as follows:

HOW TO FOLD TENT AS KNAPSACK.

Spread out the half tent with triangular end on left hand side; standing at ridge side, fold in triangular end twice, leaving length when folded, 48 inches; fold in from ground side, leaving 36 inches in width; fold blanket 20 inches by 16 inches and place on top equidistant from edges the long way of the pack across the width of the knapsack; lay valises on outer right and left edges of blanket, with the shoes in the middle, the upper placed together and laid lengthwise in the direction of the valises; fold in sides and ends of knapsack and bind lengthwise and crosswise with guy lines; attach carrying strap and the pack is complete.

COST OF TENT.

The cost of tent if made in considerable quantities would be $1 for each half, or $2 for a full tent; cost of old shelter tents, poles, and pins complete, is $3.32.

GENERAL REMARKS.

Experience has shown that a soldier will not carry any weight, if he can avoid it, that he knows will not necessarily contribute either to his protection or comfort. For this reason he was not long in dispensing with the cumbersome and uncomfortable knapsack issued to him during the last war. He found it more convenient to carry his belongings in the form of a roll hung from one shoulder to the opposite side, exactly like the knapsack herein described, and it is believed if left to his own individual choice he would prefer this roll to the most expensive knapsack and scientific arrangement of straps and buckles and slings that can be devised. It may be said with reason that to call the tent rolled and carried over the shoulder, *en bandoulière*, a knapsack, is a misnomer, that pack would be more appropriate, but the tactics recognize only the term knapsack for the medium which holds a soldier's clothing, etc., and therefore the term knapsack is retained.

General Schofield saw this tent set up, on his recent visit to this arsenal, and expressed himself as well pleased with it. He witnessed the experiment of slowly pouring a bucket of water over the sockets for the rifles, and saw that the arms were perfectly dry in every part after the experiment.

Very respectfully, your obedient servant,

JNO. R. MCGINNESS,
Major, Ordnance Dept., U. S. A., Commanding.

APPENDIX C.

TO MOUNT THE GUN SLING, PATTERN 1887.

Pass the hook end of sling through the upper band swivel in the direction of muzzle to breach, holding the dressed side of slings next to the stock. Pass the hook end through the first sliding loop, draw both ends of sling down to guard bow swivel, pass the hook end through second sliding loop, then through the guard bow swivel, from the stock outward. Then pass the other end of sling through the guard bow swivel from outside inward (toward the stock) and button it. Pass the hook end through the second loop, draw the sling taut, and hook it. Finally, slide the first loop up to the upper band swivel, and the second down to the guard-bow swivel.

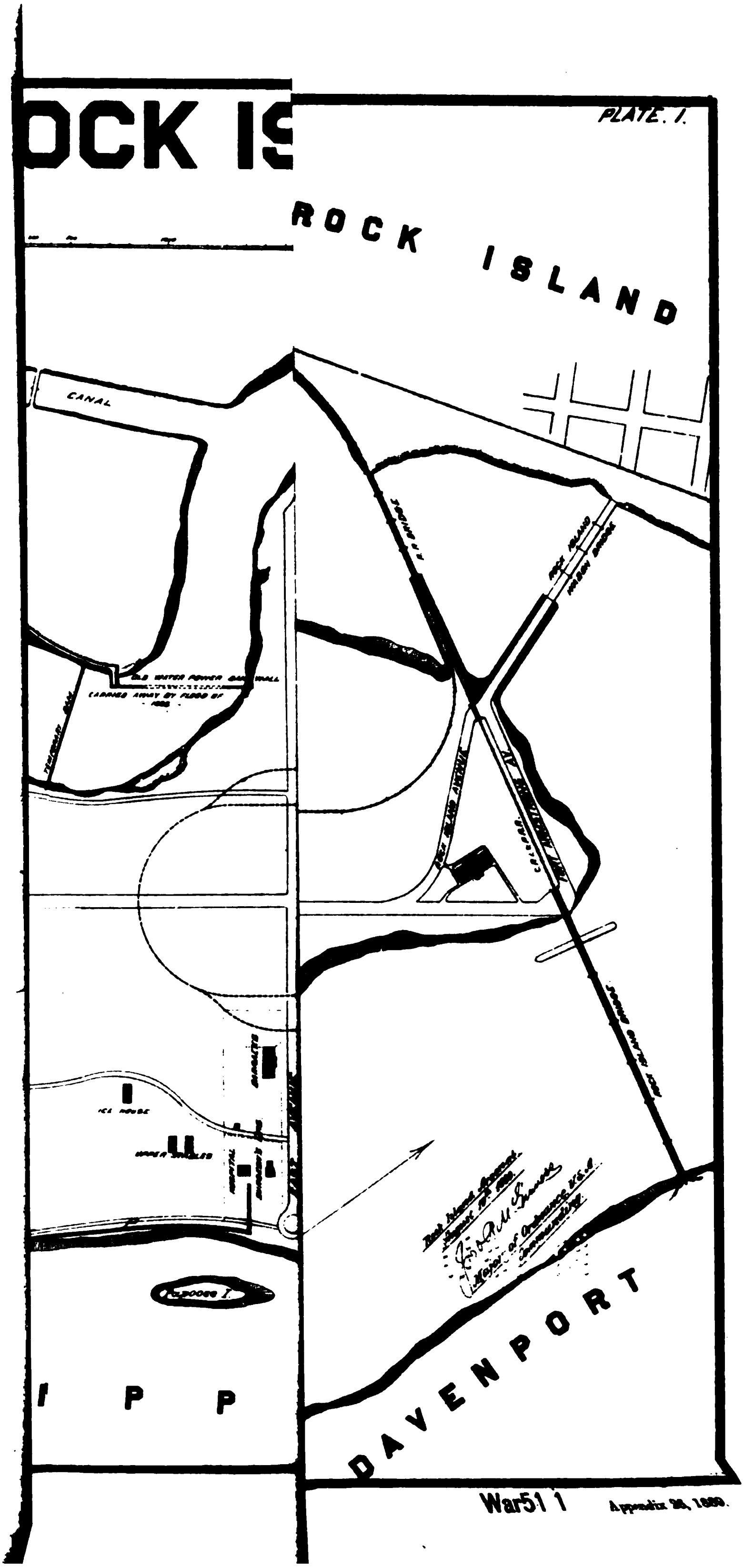
TO LOOSEN THE SLING FOR SKIRMISH FIRING.

Pass the sliding loop from guard-bow swivel up beyond the hook and unhook the sling.

Unbutton the other end and withdraw it from the swivel. Withdraw the hook end from the swivel. Re-attach the bottom end. Draw out the sling through the upper band swivel until sufficient slack is obtained.

Secure it with the hook and readjust the sliding loops.

JNO. R. MCGINNESS,
Major, Ordnance Dept., U. S. A., Commanding.

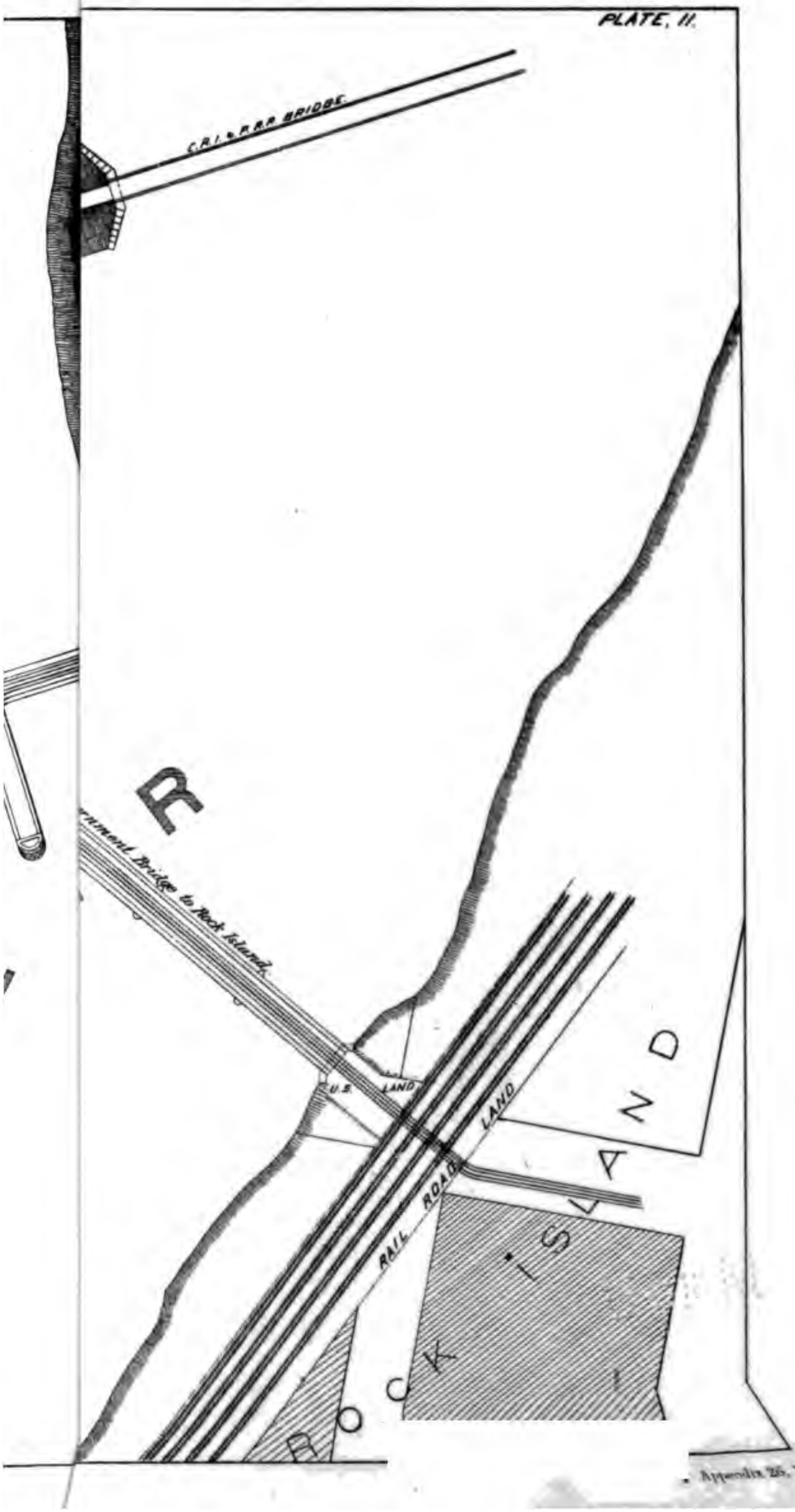


Rock Island Arsenal
August
Major of Ordnance U.S.A.
Commanding

War51 1

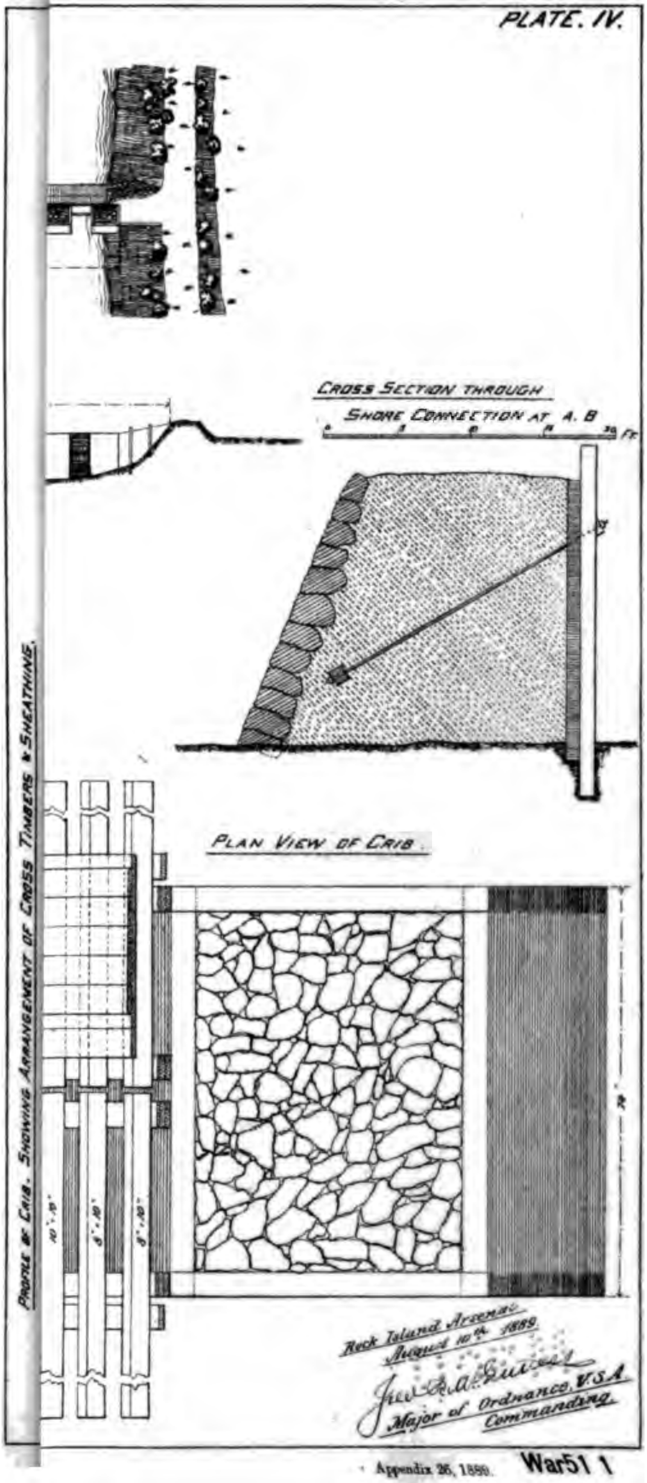
Appendix 28, 1889.

PLATE, II.



Appendix 25, 1889.

PLATE. IV.



CROSS SECTION THROUGH SHORE CONNECTION AT A. B

PLAN VIEW OF CRIB.

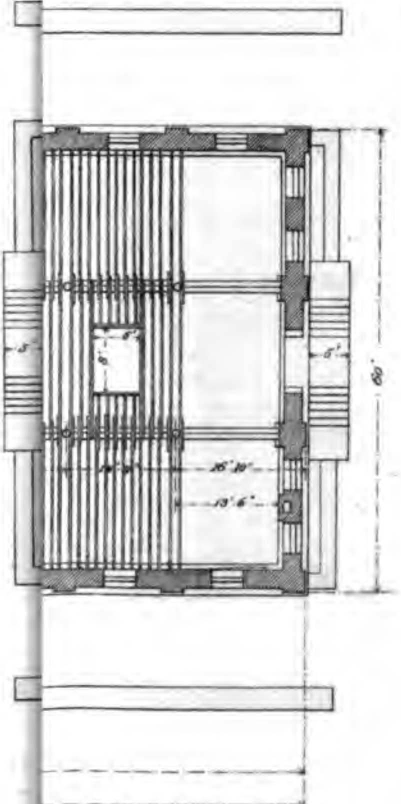
PROFILE OF CRIB. SHOWING ARRANGEMENT OF CROSS TIMBERS & SHEATHING.

Rock Island Arsenal
August 10th 1889.

Major of Ordnance, U.S.A.
Commanding.

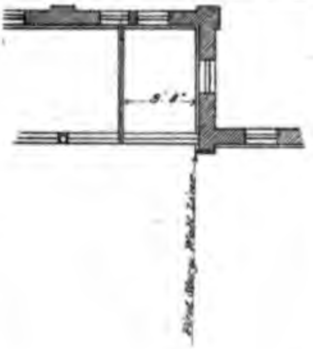
War51 1

PLATE. V.



S.W. Corner of South Portico

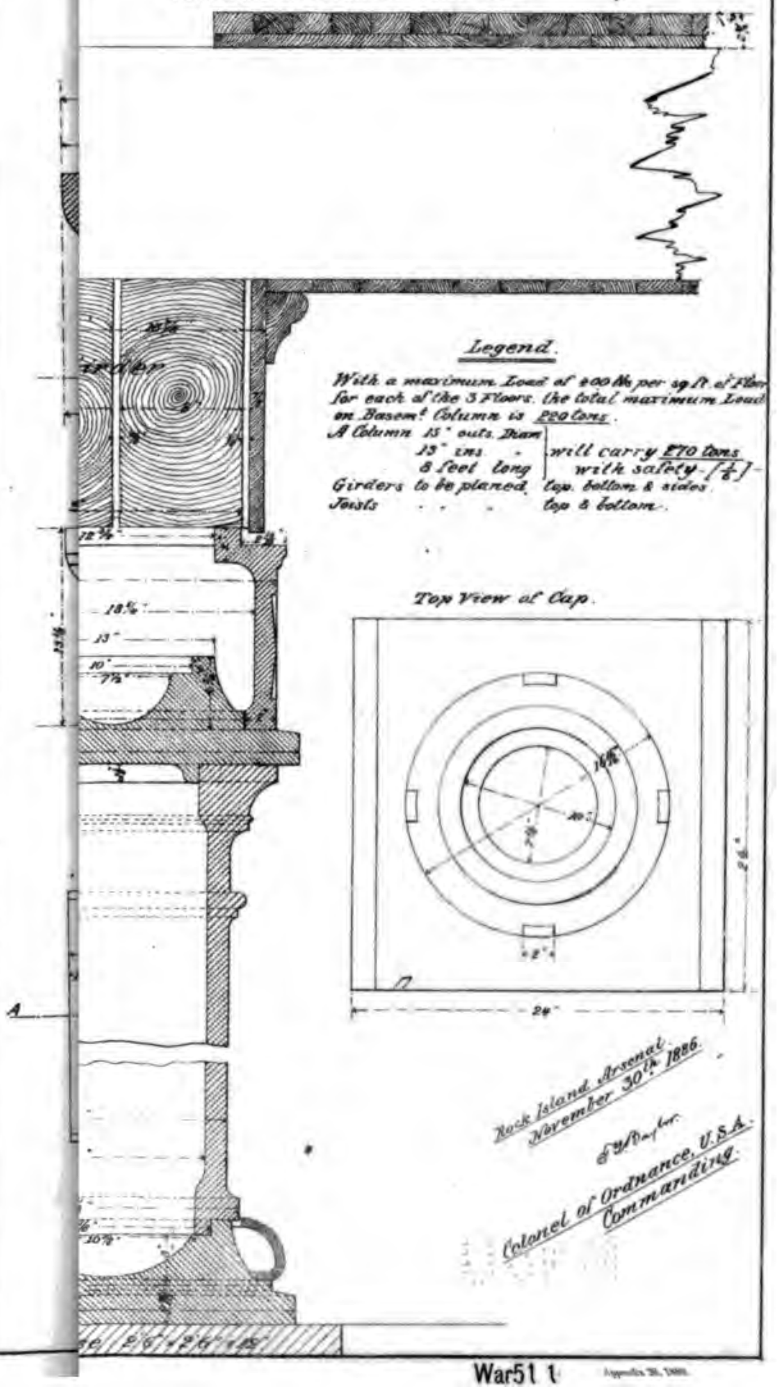
Trimmer for Stairs. Second Floor



Rock Island Arsenal.
Febr. 17th 1881.
D. W. Flagler
Colonel of Ordnance, U.S.A.
Commanding.

PLATE. VI.

VERTICAL SECTION ON LINE C. D.



Legend.

With a maximum Load of 400 lbs per sq ft. of Floor for each of the 3 Floors, the total maximum Load on Basem.t Column is 220 tons.

A Column 15" outs. Diam
13" ins. "
8 feet long
will carry 270 tons with safety -(1/6)-

Girders to be planed, top. bottom & sides.
Joists " " " top & bottom.

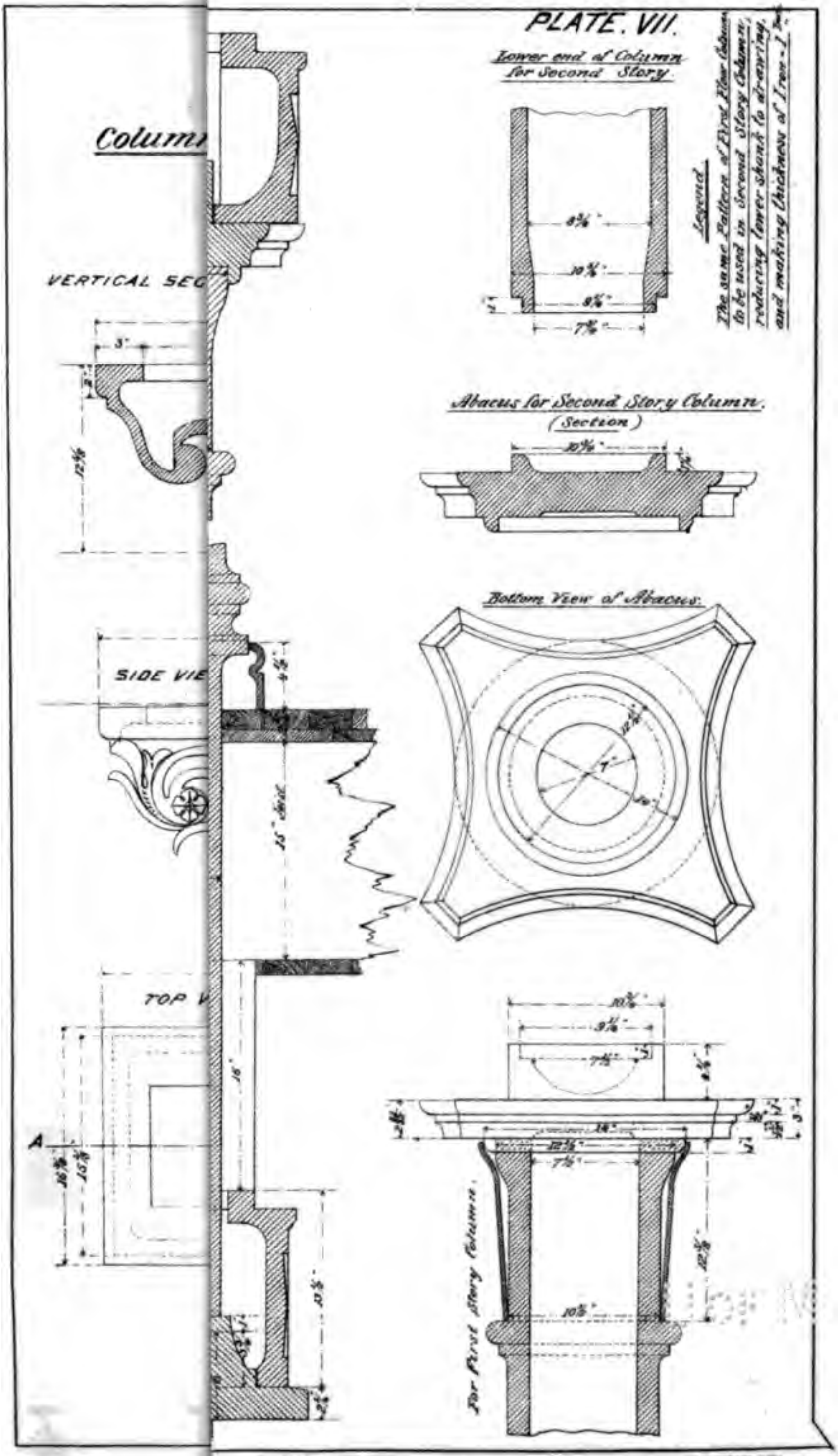
Rock Island Arsenal.
November 30th 1886.

T. G. Baylor.
Colonel of Ordnance, U.S.A.
Commanding.

War51 1

Appendix 36, 1886.

PLATE. VII.



Legend.

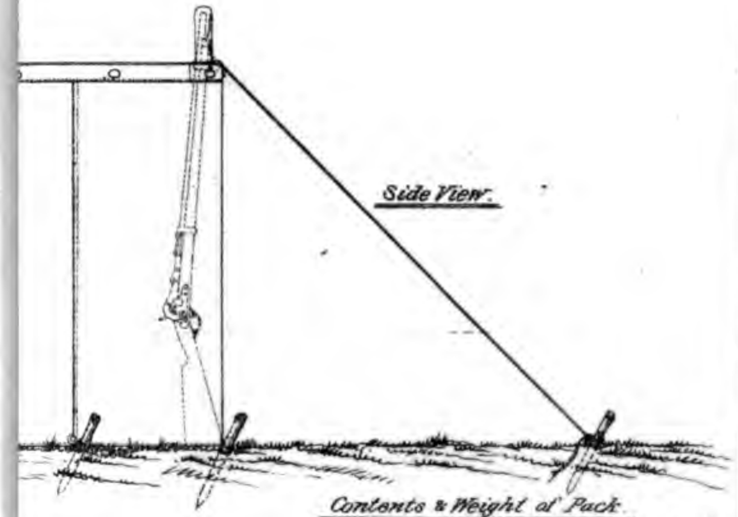
The same Pattern of First Floor Column to be used in Second Story Column, reducing lower shank to drawing, and making thickness of Iron-1

War51 1

[illegible]

LTER

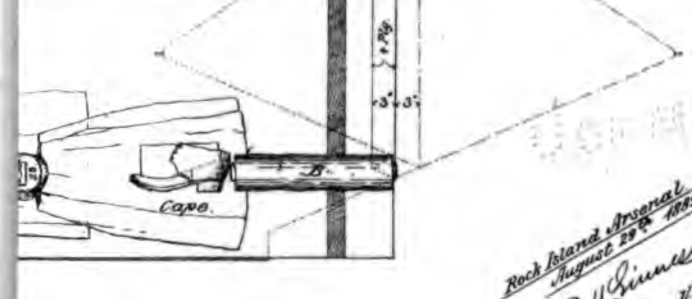
PLATE. XI



Contents & Weight of Pack.

	Lbs.	Oz.	Dr.
1 Half Tent & Guy rope	3	7	4
1 Blanket	5	3	8
1 Overcoat & Cape	5	14	10
1 Pair of Shoes	2	11	12
40 rounds of Cartridges	4	8	8
1 Valise, A. {1 Blue Shirt 2 Pairs of Socks}	1	14	6
1 Valise, B. {1 Pair of Drawers 1 Undershirt}	2	5	2
1 Shoe-Bag.		5	14
Total Weight.	26	7	–

for rolling



5 Feet.

Rock Island Arsenal,
August 29th 1889.
Jno. R. McGinness
Major of Ordnance, U.S.A.
Commanding.

War51 1

APPENDIX 26 A.

VIADUCT AT ROCK ISLAND ARSENAL.

WASHINGTON, D. C., *June* 24, 1889.

Hon. REDFIELD PROCTOR,
Secretary of War, Washington D. C.

DEAR SIR: At the last session of Congress an appropriation of some $35,000 was made in the sundry civil bill for the building of a viaduct at the south or Illinois end of the bridge leading from the city of Rock Island to the island of Rock Island, where the Government arsenal is established, but with the proviso that the one-half of the sum should first be deposited in the Treasury by the city of Rock Island. I beg leave to submit the following remarks upon this subject: The island of Rock Island lies in the Mississippi River between the city of Davenport, Iowa, on one side, and the cities of Rock Island and Moline on the other side. Bridges connect the island with the cities of Davenport and Rock Island, which were built and are maintained by the Government and which are free to the public. At the Illinois end of the bridge there are numerous railroad tracks used by the Chicago, Rock Island and Pacific Railroad Company, the Rock Island and Peoria Railroad Company, the Chicago, Milwaukee and St. Paul Railroad Company, and the Chicago, Burlington and Quincy Railroad Company, and these tracks are in almost constant use for switching purposes. The consequence is that the approach to the bridge is always dangerous to life and limb, and several people have already been killed in crossing these tracks. The proposed viaduct is simply an extension of the bridge and is for the purpose of giving safer access to the island for its officers and numerous employés, and safer crossing of the river to the general public using these bridges. It is an absolute necessity to the proper and convenient use of the island by the Government; just as much so as the bridge itself.

The proviso requiring the city of Rock Island to pay the half of the expense of building the viaduct is based upon the erroneous idea that the city of Rock Island has some peculiar interest therein. You have yourself visited the locality and are familiar with the situation. The city of Rock Island has no power to furnish the money required by the proviso. Any tax-payer within its limits could enjoin perpetually such use of its moneys.

As a member of the House of Representatives and in the public interest I ask your consideration of this subject, and, if it should seem proper to you, that you recommend to Congress the building of said viaduct by the Government at its own expense.

Respectfully, yours,

W. H. GEST,
Eleventh Illinois.

[First indorsement.]

ORDNANCE OFFICE, *Washington, July* 2, 1889.

Respectfully referred to the commanding officer Rock Island Arsenal, for report.
By order of the Chief of Ordnance.

R. BIRNIE, JR.,
Captain, Ordnance Department, U. S. Army.

[Second indorsement.]

ROCK ISLAND ARSENAL, *July* 5, 1889.

Respectfully returned to the Chief of Ordnance, U. S. Army.

In submitting the estimate for this viaduct on January 15, 1889, I recommended that the whole cost of the construction be borne by the United States. As the Government owns the bridge and the present approach, it would seem to be proper and necessary for it to build and maintain this viaduct; otherwise, should the city build a part and the Government a part, a divided responsibility would arise in the care and maintenance of this important communication with the arsenal.

A glance at the drawing which accompanied my estimate above referred to will show that this proposed viaduct is nothing more nor less than a continuation of the bridge.

I concur fully in all the views of Mr. Gest expressed herein, and respectfully recommend that Congress be asked to strike out the proviso requiring the city of Rock Island to deposit one-half the cost of the viaduct.

JNO. R. McGINNESS,
Major, Ordnance Dept., U. S. A., Commanding.

ROCK ISLAND ARSENAL,
Rock Island, Ill., October 16, 1889.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

SIR: Referring to my indorsement of July 5, 1889, on O. O. letter No. 2758 of 1889, I have the honor to inclose herewith a copy of the Rock Island Argus of Monday, October 14, 1889, and respectfully invite attention to the column therein headed "A Narrow Escape," giving a description of a collision between an engine of the Chicago, Burlington and Quincy Railroad Company and a street car. This collision occurred at the railway crossing over which it was proposed to erect the viaduct for which Congress made an appropriation, and it shows that a viaduct at that crossing is a real necessity.

Very respectfully,

JNO. R. McGINNESS,
Major, Ordnance Dept., U. S. A., Commanding.

[From the Rock Island Daily Argus, Monday, October 14, 1889.]

A NARROW ESCAPE—AN EXCITING INCIDENT SATURDAY EVENING—GROSS CARELESSNESS OF AN ENGINEER ALMOST RESULTS DISASTROUSLY AT THE FOOT OF TWENTY-FOURTH STREET—A COLLISION.

A collision between a C., B. and Q. locomotive and a street car occurred at the foot of Twenty-fourth street at 8.30 Saturday evening, which by the merest accident in the world—indeed it seemed through a marvelous intervention of some kind—did not result disastrously. From what could be seen by an Argus representative, who was a passenger on the car, and what could be learned afterward, the casualty was entirely due to inexcusable carelessness on the part of the locomotive engineer. The crossing was blocked to permit some switching to be done; a car bound for Davenport was waiting on the south side, and behind it a buggy, while a car coming into Rock Island was waiting close to the bridge, both being a safe distance from the tracks. Engine 364 of the C., B. and Q., Ed. Dempsey driver, came up on the Burlington track with four cars attached, ran up to the switch, a short distance above the crossing and dropped back on to one of the Rock Island tracks, and ran down into the lower yards of the latter company. When the locomotive had gotten about four car-lengths away from the crossing Charles H. Edgecomb, who is the street-car company's watchman at the junction and who was standing as nearly the middle of the crossing of the different tracks as he could well be, gave the signal to the cars in waiting on each side to start. The car and the vehicle on the south side crossed in safety and the car coming from Davenport, driven by Herman Jacobs, got under good headway and was down as far as the guard-house, when the driver and all on board, as well as Guard Kelly and Watchman Edgecomb, were surprised to see the locomotive start up. Guard Kelly first hallooed to the car driver, who put on his brakes and did all he could to stop, but it was too late, and then Kelly as well as Watchman Edgecomb screamed to the locomotive engineer, but the man in the cab paid no attention, and to the horror of all witnesses the locomotive and the car approached each other. The engine was moving very slowly, but fast enough, as all could see, to catch the car before it could clear the crossing, and the car was moving so rapidly that it was plainly apparent it would be impossible to stop it before it reached the crossing.

A realization of all these circumstances shot through the minds of every one witnessing the approaching collision, except perhaps the engineer, in an instant, yet the whole thing was over so quickly that no one had time to leave the car, until the danger was practically passed. Seeing that the engineer was not going to stop Guard Kelly and Watchman Edgecomb got hold of the car, and by pushing back brought it to a stop just as it reached the track of the approaching engine, the dash

of the car being scratched by the locomotive, which also stopped as the front
tended over the car track.

n it was that the passengers first left the car, though a woman from Moline had
e hysterical with fear and had given way to a series of Salvation Army yells,
er sense of reason entirely, and through her actions another lady passenger
ned a severe foot sprain.

horse attached to the car, which had been brought face to face with the loco-
e, became frantic, and, notwithstanding that the driver manifested wonderful
d heroism in sticking to his brake, turned the car completely around on the
, and started back with it toward the bridge, before the plucky driver could
ntrol of it.

rd Kelly displayed not only a spirit of bravery, but of self-possession, as did
man Edgecomb, and it was due to the work of these men that a terrible calam-
l not occur. The latter states that after the engine had backed down into the
Engineer Dempsey said "let the cars over" and he accordingly gave the signal
drivers. But the engineer claims that he did not know there was a car wait-
the north side of the track. This does not excuse him, as he could not have
n the lookout without seeing the efforts of the guard and watchman to attract
tention. Furthermore he should have satisfied himself as to both sides of the
before starting up; he was, to say the least, guilty of gross carelessness, and
safety, as well as the well known considerate disposition of the Burlington
or public interests, demands that he be made an example of.

accident illustrates the imperative need of the much-talked-of viaduct, and
r that until such time as the viaduct is built, if only until next spring, gates
l be provided. While probably nothing but care on the part of the engineer
have prevented this accident, gates would in the great majority of cases avert
r, and they might in this case had they been erected close to the track.

[Ex. Doc. No 116, House of Representatives, Fiftieth Congress, second session.]

*from the Secretary of War, transmitting, with accompanying maps and papers, a let-
from the Chief of Ordnance recommending an appropriation for the construction of a
uct over railroad tracks at Rock Island Arsenal, Ill.*

UARY 31, 1889.—Referred to the Committee on Military Affairs and ordered to be printed.]

WAR DEPARTMENT,
Washington City, January 25, 1889.

Secretary of War has the honor to transmit herewith to the House of Repre-
ives a letter of the 22d instant from the Chief of Ordnance submitting a com-
ation of the 15th instant from the commanding officer of the Rock Island
al inclosing copies of resolutions of the city council of Rock Island and of the
ns' Improvement Association in favor of an appropriation for the construction
iaduct over the railroad tracks on the approach to the wagon-bridge to the
, at an estimated cost of $35,234.65.

ill be observed that the Chief of Ordnance recommends the scheme, with the
o, however, that the right and title to and right and authority over the prem-
be used for the construction and maintenance be first conveyed to the Govern-
and that the owners of property abutting upon the proposed viaduct release to
ited States all claims for damages that might arise under its construction.

WILLIAM C. ENDICOTT,
Secretary of War.

SPEAKER OF THE HOUSE OF REPRESENTATIVES.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., January 22, 1889.

: I have the honor to transmit a communication from the commanding officer
k Island Arsenal, inclosing resolutions of the city council of Rock Island and
f Citizens' Improvement Association, etc., in favor of an appropriation for the
uction of a viaduct over the railroad tracks at the approach to the wagon-bridge
island. The estimated cost is $35,234.65.

inclosed papers clearly show the absolute necessity for a viaduct, and the appro-
n asked for is recommended with the proviso:

ovided, That the city of Rock Island, by proper instrument in writing, first con-
the Government of the United States the right and title to and right and au-
y over the premises to be used for the construction and maintenance of such

viaduct: *And provided further*, That the owners of property abutting upon said proposed viaduct, by proper instrument in writing, first release to the Government o the United States any and all claims for damages that might arise to them or any o them by reason of the construction and maintenance thereof."

If this meets the approval of the Secretary of War, it is suggested that these paper be submitted to the Senate Appropriations Committee for its action.

Very respectfully, your obedient servant,

S. V. BENÉT,
Brigadier-General, Chief of Ordnance, U. S. A

The SECRETARY OF WAR.

ROCK ISLAND ARSENAL,
Rock Island, Ill., January 15, 1889.

SIR: I have the honor to report that the approach to the south end of the Roc Island wagon-bridge is crossed at grade by the tracks of the Chicago, Rock Islan and Pacific, the Chicago, Milwaukee and St. Paul, and the Chicago, Burlingto and Quincy Railroads, and as these tracks are being constantly used in switching a travel to and from the arsenal is rendered extremely unsafe and dangerous; hence i is proposed to build a viaduct over these tracks by raising the floor of one span o the present bridge and constructing the necessary approaches thereto, as shown in th accompanying drawing.

The approach on the Rock Island side for this project would extend beyond th present Government limits, but the city of Rock Island has given asssurances that i will cede to the United States all the land needed for this purpose.

As the Government owns the bridge and the present approach, it would seem prope and necessary for it to build and maintain this viaduct; otherwise should the cit build a part and the United States a part a divided responsibility would arise in th care and maintenance of this important communication with the arsenal. I hav therefore had a survey made of the premises, and a sketch made of this proposed viaduct, and inclose an estimate of its probable cost.

If you approve of this scheme I would recommend that Congress at its present session be asked to appropriate the necessary funds.

It will be noticed that the resolution of the city council of Rock Island grants t the United States all necessary privileges over said streets for the use of said viaduct but is silent as to any claims that may be brought in the future by owners of property abutting on such portion of said street through which the viaduct runs.

The following papers relating to this subject are forwarded herewith:

Proposed viaduct. Plan Plate L. Proposed viaduct, elevation, Plate 11. (Tracing separately by mail.)

Resolution of Citizens' Improvement Association of Rock Island City, passed October 31, 1888.

Resolution of city council of Rock Island, passed and adopted November 9, 1888, (certified copy).

Letter of the mayor of Rock Island transmitting copy of resolution of city council of November 9, 1888.

Estimate of cost of the proposed viaduct.

Very respectfully, your obedient servant,

JOHN R. MCGINNESS,
Major, Ordnance Dept., U. S. A., Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

ROCK ISLAND ARSENAL,
Rock Island, Ill., January 15, 1889.

Estimate of cost of proposed viaduct.

1,100 cubic yards earth-work	$385.
800 cubic yards first-class masonry	12,000.
6 deck-plate girders, 45 feet each	9,240.
1 100-foot through-truss bridge	5,160.
New floor beams and lateral bracing on the Rock Island wagon-bridge	2,010.
57,000 feet pine lumber	1,368.
54,500 feet oak lumber	1,798.
3,500 pounds nails (20*d.* and 60*d.*)	70.
	32,031.
For engineering contingencies, etc., 10 per cent	3,203.
Total	35,234.

MAYOR'S OFFICE,
Rock Island, Ill., November 10, 1888.

SIR: I have the honor to transmit herewith a certified copy of resolutions passed by the city council of this city, the 9th instant, relative to the construction of a viaduct at the south approach of the Government bridge, leading from Twenty-fourth street in this city to the island of Rock Island, and to request that the subject matter embodied in these resolutions may receive your favorable consideration and official action at your earliest convenient opportunity.

Awaiting your reply, I remain always and truly yours,

V. M. BLANDING, *Mayor.*

Col. T. G. BAYLOR, U. S. A.,
Commanding U. S. Arsenal, Rock Island, Ill.

CITY COUNCIL CHAMBER,
Rock Island, Ill., November 9, 1888.

Whereas it has been formally brought to the attention of this body that the approaches to the wagon-bridge leading to the island of Rock Island, and owned and controlled by the United States Government, are dangerous to public travel by reason of the many railroad tracks passing and immediately in front of the south end of such bridge; that such danger is about to be greatly enhanced by the laying of a street-railway track and the passage of street cars over such tracks and upon such bridge; that serious accidents have already occurred at this point, and more serious ones will inevitably occur when said street railway commences operation; that common humanity and a just consideration for the lives of the thousands crossing the bridge at that point require that a viaduct be built from the bridge over such railway tracks; and

Whereas the city of Rock Island has no power to act, and no authority over the approaches to said bridge, the same being the property of and under the exclusive jurisdiction of the United States Government: Therefore,

Be it resolved by the city council of the city of Rock Island, That the commandant of the United States arsenal at Rock Island be respectfully requested and urged to call the attention of Congress through the War Department to this matter, and take such steps as will secure an appropriation to build the needed viaduct and raise the south end of the bridge whatever may be necessary to make the proper grade from said bridge over such railroad tracks; and

Be it further resolved, That the city council of the city of Rock Island hereby pledges itself as far as possible to assist the commandant of Rock Island Arsenal in such work by granting to the United States Government all necessary terminal and other privileges and authority over the street of said city abutting said bridge for the use of such a viaduct.

Resolved, That the mayor shall forward a copy of these resolutions to Col. T. G. Baylor, commandant at the Rock Island Arsenal.

STATE OF ILLINOIS, *City of Rock Island, ss:*

I, Robert Koehler, city clerk of the city of Rock Island, Ill., do hereby certify that the above and foregoing is a true copy of the preamble and resolutions passed and adopted by the city council of the said city at a meeting held November 9, 1888. Witness my signature and the seal of said city hereto affixed this 10th day of November, A. D. 1888.

[SEAL.]

ROBERT KOEHLER,
City Clerk.

CITIZENS' IMPROVEMENT ASSOCIATION OF ROCK ISLAND,
Rock Island, Ill., October 31, 1888.

Whereas the approach to the south end of the Government bridge crossing the south branch of the river from this city to the island is now a great thoroughfare for all kinds of travel, which is constantly on the increase, and by reason of the railroad tracks intersecting it is extremely unsafe and dangerous; and

Whereas it is proposed to lay a double track horse railroad upon said bridge and intersect said railroad track on said approach at grade, which will largely enhance the present danger and make hazardous and perilous the travel by horse-cars; now be it

Resolved, That it is the considerate judgment of this association that, for the accommodation and safety of said travel and the safety of those who may travel in horse-cars, there ought to be built a viaduct over said railroad tracks on said approach, and to this end said Government bridge raised to the height to correspond to the necessary elevation of such viaduct, and we hereby respectfully call the attention Colonel Baylor, the commandant of Rock Island Arsenal, to this want and ask t he take such steps as shall seem to him proper to secure the required action of United States Government in reference thereto. Further be it

Resolved, That we respectfully ask that the city council take such action in matter as to assure to the United States Government, if it concluded to build s viaduct and desires to own and control the same, a grant of the use and contro such parts of the street leading to such approach as may be necessary for such len of time or a term of years, as may be satisfactory to the Government, and to take s further action necessary to fully meet and be in accord with the wishes of Colo Baylor, or the engineers in charge of the construction of such viaduct.

Resolved, That a copy of these resolutions shall be sent by the secretary of t association to Colonel Baylor and to the mayor and city council.

The above is a copy of the resolution offered by Mr. J. M. Buford, and unanimou adopted by the Citizens' Improvement Association at their meeting on October 1888.

FRED. HAAS, *President*.
T. J. MEDILL, JR., *Secretary*.

APPENDIX 27.

ESS REPORT OF WORK DONE UNDER CONTRACT AT THE WATER-
T ARSENAL, WEST TROY, N. Y., DURING THE FISCAL YEAR END-
JUNE 30, 1889.

GUN FACTORY BUILDING.

Army gun factory, built of brick, with iron roof trusses, and a
oof is being erected.
composed of a central section and one wing to the north of that
, providing for further extension to the south. The center sec-
ill then contain a boiler-house and an engine-room with a shrink-
50 feet deep excavated in the shale rock, and offices, inspectors'
tool rooms, etc., common to the north and south wings.
north wing is divided longitudinally by two rows of piers sup-
g arches, which arches having their spandrel spaces filled in,
a continuous wall supporting the main roof. This wall is pierced
each arch with window-openings to light the main aisle of the
ng. On either side of the piers is a space 22 feet wide, forming
st and west aisle. The exterior walls of these aisles support the
of the side roofs. These walls are also pierced with large win-
penings so that the building is well lighted throughout. The
ength of the building between wall lines is 566 feet 2 inches, the
l section being 166 feet 2 inches long, and the north wing 400 feet

main aisle is 75 feet wide in the clear, forms the principal struct-
nd extends throughout the entire length of the building. Its
to the top of the walls at the eaves is 50 feet, and to the ridge
above the floor line.
h side aisle communicates with the main aisle by twenty-two large
l openings.
foundation walls are of cut stone, resting on a good bed of con-
which lies on a foundation of shale rock. The building is
hed with cut stone door-sills, window-sills, belt courses, coping
, and string stones. The material is grey-wacke, furnished from
gelow blue-stone company's quarries at Malden, N. Y.
expected that the building will be under roof before December.
ain aisle of the building contains bridges for overhead traveling
, for its entire length, covering a floor space of 562 feet 6 inches
by 50 feet width.
traveling cranes, each of 30 gross tons capacity and 35 feet hoist,
ing manufactured under contract by the Morgan Engineering
ny, of Alliance, Ohio, and will be delivered in running order by
d of this year.

MACHINERY.

h machinery for the factory as is of the ordinary commercial pat-
or differs but little from them, is under advertisement, while

drawings for the special machinery required are being made as r
as possible.

RAILROAD.

Connected with the gun factory a railroad has been built exte
from the Delaware and Hudson Canal Company's line on the
across the arsenal grounds, through the factory to the Hudson
on the east. For facilitating the handling of material, switches
turn-table are located at suitable points, and a railroad-track sc
placed at the end of one of the switches. The rails are of the best
ity, the track is well ballasted, the crossings and switches are all
proved patterns, and it has already been of great benefit to the a
as affording means of transporting building materials directly t
arsenal grounds.

RAILWAY BRIDGE.

At the point where the railroad crosses the canal a wrought-iro
eted lattice single-track through railway bridge provided with a w
floor suitable for highway traffic has been erected. This bridge i
ported by masonry abutments and is about 100 feet long. It is u
ally strong, being intended to support in addition to a locomotiv
its tender a weight of 200 tons distributed over a distance of 62 fe
twenty-four wheels.

OFFICERS' QUARTERS.

In addition to the above two sets of brick quarters for officers a
ing erected. The foundations are made of stone masonry resting e
directly upon shale rock or upon concrete. The water table, the
and caps, where used are made of brown stone. The buildings a
be completed throughout and ready for occupancy by the 1st of
vember in the current year.

PROJECTILE FOUNDRY.

Under subhead 1 of the appropriation for Armament of Fortifica
made by the Fiftieth Congress, September 22, 1888, it is provided
$10,000 of the $500,000 therein appropriated shall be expended for
viding increased facilities for the manufacture of projectiles. It ha
been decided that the projectile foundry to be established under
act should be located at this arsenal, the large iron store-house
ated east of the canal and south of the lower machine-shop wa
lected as the best building available for the purpose. A large q
tity of niter and sulphur was stored in this building, which had n
sarily to be moved. During the months of January, February,
March about 5,000,000 pounds were placed on cars in arsenal gro
and shipped to the United States powder depot, Dover, New Jers

The design of the foundry (limiting its capacity for the present t
casting of projectiles only) calls for a sand and core-room, also a
tern-room, three core ovens, one of which is especially adapte
heavy projectiles, one 10-ton reverberatory furnace, and one
cupola furnace, with flues, smoke-stacks, etc., complete. The ma
ery and appliances are three metallic jib cranes, 20 feet swing,
tons capacity; a grinding pan for refractory material and sand in
room; one No. 7 Sturtevant steel blower with blast pipes, the n
sary shafting and wire-rope transmission for obtaining power fro

ine-shop. Narrow-gauge railway tracks, turntables, etc., are de-
ed for transportation of material and work in and outside of foun-
building. Bins are also to be provided for the storage of coal, coke,
The capacity of the foundry, when running the usual eight hours
lay, will be about 2,700 tons per annum.

e work of establishing the foundry began about the 1st of April
emoving a part of the flagging on the ground floor, and the wooden
s of the galleries. Excavations were then made for the foundations
e ovens, cranes, furnaces, etc. On account of the presence of water
depth of a few feet below the ground considerable difficulty was
untered in procuring suitable foundations for these structures, mak-
much larger quantity of concreting necessary than was at first
ipated. These obstacles have been to a great extent overcome,
the foundry is now in a fair way to completion. It is thought that
bout the 15th of August the work of casting projectiles can be
n.

e foundry as at present arranged takes up about one-half of the
space of the building. The design contemplates an extension of
lant, if required, so as to admit of the casting of mortars and other
y castings. The present brass foundry should also be removed to
building. This will require the erection of suitable furnaces, etc.,
hich space has been provided.

e arsenal carpenter-shop was selected as the room in lower ma-
e-shop the best adapted for the finishing-shop for projectiles. This
tion was governed by the fact that the room was located near the
dry, admitting of the easy transportation of work to and from the
dry by a narrow-gauge railway. A portion of the space used for
ge was taken for the new carpenter-shop. In this space a new
has been laid, hangers, shafting, etc., have been procured and
ed in position, and the work of removing this shop is about com-
d. A room adjoining the finishing-shop has been fitted up as a
ng room, in which has been erected the testing machine recently
ved from Sandy Hook.

J. M. WHITTEMORE,
Colonel, Ordnance Department, U. S. Army, Commanding.

APPENDIX 28.

REPORT OF PRINCIPAL OPERATIONS AT UNITED STATES POWDER DEPOT, DOVER, N. J.

UNITED STATES POWDER DEPOT,
Dover, N. J., August 14, 1889.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In compliance with the requirements of existing orders, I have the honor to submit a report of the principal operations at this depot during the fiscal year ending June 30, 1889.

The following statement shows receipts, expenditures and balance of funds for the year:

Funds.	Ordnance service 1889.	Powder depot.			
		1.	2.	3.	
		For completing Magazine No. 4.	For repairing Magazine No. 1.	Proportional part of appropriation for fiscal year 1888 (act of Congress June 30, 1888).	Appropriation of 1888.
On hand from last year	....	....	....	....	$552.47
Allotted by Ordnance Office	$3,000.00	....	....	....	....
Appropriated by Congress	....	$18,000.00	$1,150.00	$8,917.80	....
Expended	3,000.00	3,800.35	1,103.29	1,510.69	552.47
Balance on hand	....	14,199.65	46.71	7,407.11	....

Attention is respectfully invited to my report of July 6, last, giving in detail all of the expenditures under above appropriations; bills aggregating $22.75 under ordnance service 1889, outstanding at that time, have since been paid.

MAGAZINE NO. 4.

The work done on this building was as follows:

Two wells, one 8 feet and the other 14 feet deep, for terminals of lightning-conductors dug and lined with bricks.

Four hundred feet ditches for lightning-conductor terminals dug and filled in.

Twenty-two hundred feet galvanized iron wire-rope for lightning nductors, and 2,507 pounds galvanized iron lightning-conductor at- chments, placed on building.

Twenty-six hundred cubic feet earth and rock graded around foun- ation and removed.

Eight window frames made and set, and eight pairs window sash put .

Ten thousand square feet of flooring laid.

Sixty-five hundred square feet of siding put on.

Doors, windows, and columns (24) cased.

Eight inside wire-screen shutters and 8 window-shutters made and ut on.

Inside wood-work oiled; inside columns and iron-work painted. Roof .2,000 square feet) and iron doors, shutters, and leaders painted with rince's metallic paint. Outside brick work (10,000 square feet) painted vo coats.

With the exception of some alterations to roof of this magazine, as thorized in your letter of July 19, 1889, this magazine is complete.

MAGAZINE NO. 1.

This magazine, commenced by Major (now Lieut.-Col.) Parker in 80, was the only one provided with an accessible cellar. In order at this might be utilized for storage purposes, 3,800 cubic feet of earth as excavated and 10,000 square feet of concrete floor laid and the cellar hitewashed. The ground around the magazine was graded and the eps, platforms, and brick and stone work were pointed.

The floor boards of this building, having been put down before they ere thoroughly seasoned, had shrunk so much as to necessitate either new floor or filling of the spaces between boards. It was decided as .e best and cheapest remedy for the trouble to lay a new floor of seven- ghth-inch boards on the one already down, crossing boards. Ten ousand square feet of new flooring was thus laid. Eight window- ames and sash were put in, and wire screens fitted to inside of same. opper-wire netting was put over inside ventilators and iron netting er cellar windows. The iron window shutters and hinges were re- ired; the roof scraped, and all painted.

The outside brick-work was painted two coats to correspond in color the other magazines and buildings.

For information as to storage capacity and present condition of all e magazines, attention is invited to my reports of June 15 and 29 last.

During the year, in addition to the regular police, all the grain and y required for the supply of this post for a year were cut and stored, d 50 acres of ground in the vicinity of magazines cleared of brush d burned over. Besides which, 2,078,126 pounds crude niter, 1,891,- .7 pounds fused niter, 1,455,670 pounds refined niter, and 504,666 unds sulphur were received and stored in magazines.

I regret to say that nothing has yet been done—for want of funds— improve the condition of the guard and engine house, reported upon ugust 16 and December 15, 1888, and on May 22, 1889. If a small rt of the $7,407.11 remaining of the "proportional part of the appro- iation for the fiscal year 1888, under joint resolution of June 30, 1888," uld be used, as it would have been had I known in season that it was ailable, this building could be thoroughly repaired and protected om further injury from the causes given in my reports referred to.

Respectfully submitted.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., Commanding.

APPENDIX 29.

REPORT OF WORK ON ARTESIAN WELL, AUGUSTA ARSENAL, GEORGIA.

AUGUSTA ARSENAL, *June* 30, 1889.

Boring, constructing, and equipping an artesian well.

The sundry civil bill making appropriations for the fiscal year ending June 30, 1889, contained a provision to the effect that the sum of $10,000 is hereby appropriated to bore, construct, and equip an artesian well at the Augusta Arsenal, the money to be expended under the direction of the Secretary of War.

Proposals were advertised for, calling for an 8-inch well to be 1,500 feet deep if required by the United States. The following bids were received in response to this call:

William D. Chapin, Brooklyn, N. Y., $6.75 per foot.

E. F. Joyce, St. Augustine, Fla., $6.55 per foot.

Sparks & Allen, Dundee, Mich., $4.25 per foot for the first 500 feet; $2.75 per foot for the balance of the well.

Daniel Dull, New York City, $9 per foot.

Murphy Bros., Milledgeville, Ga., $8 per foot.

H. W. Carter, St. Louis, Mo., $6 per foot.

Enterprise Drilling Company, Pittsburgh, Pa., $7 per foot for first 200 feet; $4 per foot for next 800 feet; $5 per foot for next 500 feet.

In accordance with the law the contract was awarded to the firm of Sparks & Allen, Dundee, Mich., the lowest bidders. They, however, failed to execute the contracts when these were sent to them for their signature and bonds, and the contract was then, under the instructions of the Chief of Ordnance, awarded to the next lowest bidders, the Enterprise Drilling Company of Pittsburgh, Pa., and was approved of date January 7, 1889.

The Enterprise Company at once began the construction of the derrick and other necessary structures, and commenced the boring of the hole February 20, 1889, with the most approved tools and appliances used in modern artesian well boring, and with expert workmen brought from western Pennsylvania, with the following results:

In February, bored through white sand, red clay, and gravel, 85 feet.

In March, bored through red clay, kaolin, gravel, and sand to bed rock at the depth of 280 feet, and through this rock, a very hard and tough chlorite slate, to the depth of 370 feet from the surface. The well was cased to bed rock, shutting off surface water.

In April, bored to near the 700-foot depth, through chlorite slate with occasional thin seams of quartz or flint rock. The rock varied in hardness, occasionally being comparatively soft, but in general very hard and tough, the softer rock being met with immediately above the water-courses, and including them, and the hardest immediately below these courses.

The well, after the casing was put in, was entirely dry to the depth of some 325 or 330 feet, where a very small water-course was reached. The water from this source could, however, be readily exhausted by the "bailer." When near the 500-foot depth, the first water-course of note was reached, and the water from it stood in the well about 150 feet deep, or at its surface some 350 feet from the top of the well.

The second water-course was reached at about the 600-foot depth, raising the water in the well some 25 feet—to the depth of 325 feet from the surface. The third water-course was reached at about the 690-foot depth and this raised the water to within 198 feet from the surface.

The water in the well greatly impeded the boring, making it very desirable to have a dry hole, but after the first water course was reached it was found impossible, by the most rapid working of the large bailer, to effect this or to materially decrease the quantity of water in the well.

Immediately below the last water-course the auger reached a stratum of quartz or flint rock, inclined at a very high angle of elevation, which shunted the drill from its vertical course, and the hole followed the incline of the rock. This was indicated by the constrained working of the auger, and by the marks on the bits when withdrawn from the well for resharpening. The last weeks of the month were spent in endeavoring to get a "good bottom" to the well. This is ordinarily accomplished by filling up the hole, by a wooden plug or very hard rock, to above the defective part and reaming it down.

In May the entire month was spent in endeavoring to rectify the well's departure from a vertical course and in futile efforts to start the auger straight again. It is well known that unless the hole keeps straight and vertical the end of our boring is not far distant.

In June, having gotten an apparently good bottom to the hole, drilling was resumed, but with the precaution of using a winged-sub (the most approved appliance) to center the stem and bit and prevent a departure from a straight course. After a few days, however, it became apparent from the marks on the bits, etc., that the direction of the hole was still at an incline but not to a great degree. The reamer was continually in use, in turn with the bit. By the end of the month the depth of 795 feet was reached. The strata all seem to have a very steep incline. Unless the character of the rock changes and becomes quite soft, or their inclination changes to an opposite direction, boring must soon come to a conclusion.

The rock continues to be in general chlorite slate, but towards the bottom of the well approaches a greenish quartz rock.

Numerous specimens of the clay, sand, kaolin, gravel, rock, etc., have been gathered from the borings and are labeled and cased for future reference.

AUGUSTA ARSENAL,
Augusta, Ga., July 20, 1889.

CHIEF OF ORDNANCE,
Washington, D. C.:

SIR: I have the honor to report that work upon the artesian well has about come to a conclusion. The rock has been throughout a very hard chlorite rock, with occasional seams of quartz or flint, the strata are

APPENDIX 30.

REPORT OF PRINCIPAL OPERATIONS AT CHEYENNE ORDNANCE DEPO DEPARTMENT OF THE PLATTE.

CHEYENNE ORDNANCE DEPOT,
Cheyenne, Wyo., August 17, 1889.

CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: I have the honor to submit the following report upon the ope
ations of the Ordnance Department in the Department of the Platte f
the fiscal year ending June 30, 1889:

CHEYENNE ORDNANCE DEPOT.

When the ordnance depot for the Department of the Platte was fir
established it was thought best to locate it at the city of Cheyenn
Wyo., on account of its central position in regard to the posts of th
department, and also on account of the lack of rail transportation fro
Omaha to the posts situated north of the line of the Union Pacific Rai
road, there being at that time ready wagon transportation from Chey
enne to these forts.

But time has changed all of these relative positions so that to-day
with railroads radiating from Omaha to the forts north and west, ther
seems no good reason for leaving the depot at Cheyenne, as Omaha i
now relatively nearer those posts than is the former city.

Again, as all of the ordnance stores received at the depot come fro
the east, it necessarily follows that many of them pass over the railroad
only to be returned at a later date to some of the posts that they hav
passed in going to Cheyenne, and thereby the cost of transportation i
greatly increased.

It is true that the posts west of Cheyenne are one day further from
Omaha than they are from the former city, yet the saving in regard to
time for all of the other posts more than compensates for this sligh
loss.

Such a change in the location of the ordnance depot is, I believe, con
templated this coming year, and the necessary steps to effect this ar
now being taken, a portion of what is known as the quartermaster
depot in the city of Omaha on the line of the Union Pacific Railro
having been set aside for that purpose.

When the change is made, then all of the posts in the department w
be in direct rail communication with the depot, with three or four t
will have to add a few miles of wagon transportation at the end of t
railroads. And this number will diminish as these roads are p
farther west.

Owing to the lack of appropriations there has been but little w
undertaken at the depot outside of the issue and receipt of stores,

iling of the leather goods, and the care of the small-arms. There erefore been no men detailed on extra duty at the depot as has he case in the years past, the regular enlisted force of the ord- etachment performing all of the required work. Time has, how- een found to manufacture the following stores for issue:

alls, lubricated	14,600
s	200
artridges for 3-inch gun	2,877
s covered; dyed duck	100

ORDNANCE STORES ISSUED TO TROOPS.

f the ordnance stores issued to the troops in this department the past year have given universal satisfaction, and not an in- of complaint has been heard in regard to them from any one.

new Buffington rear-sight has now been supplied to all of the y troops; it gives great satisfaction, and all who speak of it do he highest terms. A few fractures of the sliding-leaf have oc- , owing to the carelessness of the men in clamping it below the rd mark and then suddenly raising the sight, when as it projects the hinge it either snaps off or bends the leaf. If these could be actured so that the men could not thus clamp them it would be rovement to the sight.

old intrenching tools have been discarded and turned in to the and the hunting-knife, the scabbard of which has been arranged hook to attach it to the cartridge belt, has been substituted for All of the infantry troops in the department have been supplied ese, and they will be thoroughly tested this summer at the en- ent of the troops at Camp George Crook, near Fort Robinson, where all of the troops in the department will assemble.

TARGET PRACTICE.

cost to the Government for the annual target practice of the is far more than the cost of the ammunition used. Many rifles ined at the rifle range, either through the carelessness of the men bursting of the shells. Many officers claim that one season at practice is harder on the rifles than one campaign.

r a shell has become fastened in the rifle many of them are ruined careless use of the headless shell extractor. There should be an forbidding the use of this tool except by non-commissioned officers ave been thoroughly instructed in its use. At one post in this ment such an order has been issued and the result is that from ost no reports are received of the rifles being injured through this

ising some of the shells too long they become weakened so that urst in the chamber. I would add my voice to that of those who receded me in urging that a brass shell be furnished by the de- nt for reloading purposes only. There is not much doubt but ich a shell would result in saving many rifles now ruined. They remain in storage so short a time that any detrimental action of wder due to the brass shells would not be observed. If, how- his objection is the only one that now prevents the issue of such idge, I would suggest that they be tinned in the same manner as he experimental Morse cartridges issued a few years ago.

n the few reports that reach this office concerning the bench set ding tools it is observed that they are not handled with that care nor given that attention that they deserve, so that at many posts t soon become disabled. At some of the posts every one is allowed to them, whether they understand their mechanism or not, and the re can readily be imagined. To obtain the best results for these tool would seem good policy to give a course of instruction to those who be called upon to use them during the target season and to allow one else to handle them. This subject would seem to be as m worthy of study for the enlisted men as is the subject of tactics.

Very respectfully, your obedient servant,

MARCUS W. LYON,
Captain, Ordnance Dept., U. S. A.,
Chief Ordnance Officer, Department Platte, Commandin

APPENDIX 31.

IE NEW FIRE-PROOF SHOPS AT THE NATIONAL ARMORY, SPRINGFIELD, MASS.

(11 plates.)

The old shops have been outgrown, lacking light, strength, and space r ever-accumulating machinery and the fire-proof qualities highly es- ntial for the protection of the large plant of valuable machines, to re- ace which would require a large expenditure of time and money.

A fire once under headway in the old shops, from the inflammable nat- e of the dry flooring and interior timbers, saturated more or less with from long-continued use, would destroy this plant in a very few min- es, and virtually close the armory for years.

The two new fire-proof shops (now essentially completed and one occu- ed), the milling and carpenter and stocking shops, are but part of the oposed plan of the fire-proof plant in "Federal Square," the armory closure east of Federal street, which passes between it and the inclos- e of the present "Hill," or finishing shops.

These buildings, counterparts of each other in size and plan, are two ories (11 feet between floors and ceilings, window-frames 7 feet 8 ches by 4 feet, tops 10½ inches below ceilings), basement (9 feet be- een floor and ceilings) and attic high, cruciform in plan (279 by 76 et, length of arms, by 36 feet wide, outside measurement), opposite d parallel 430 feet apart.

The milling shop is on a line with the old machine and filing shops ross the street and connected with them, for transmission of power, s, and water, by a tunnel under the street.

The carpenter and stocking shop is not yet occupied, can not be until e completion of the proposed third and last building (458 feet long th transepts and rear wings of same general plan, height, etc., as the hers) which will connect the two and form, with them and the old illing shop, offices, and connected buildings opposite, a quadrangle.

This quadrangle will be thrown open to Federal street on the Federal uare side and the present east gate of the old finishing shops in- osure moved opposite the armory offices, about the center of the long le of the quadrangle.

The main rooms, running full length of the buildings, are the shop oms, the transepts in the center providing, in front, the offices on each or for the foremen, the elevator shaft, stairway, hatchway for hoist- g apparatus, and entrance halls; in rear, the inspectors' rooms on ch floor of the main shop rooms, and in the basement the closet latrine om. The main basement rooms—the buildings being high up and ll drained, well lighted, and heated like the upper stories—make fine op rooms for the heaviest machinery. The central portions, between e latrine rooms and opposite compartments in front, are fitted up with cupboards on each side against the walls for the clothing, towels, etc., of the workmen and the lavatory troughs. This arrangement does away with the clothing cupboards between the windows in the main work rooms as in the old shops, and each building having its own closets, with every convenience, removes the necessity of workmen leaving the buildings, in which they work, to go to distant places, through other shops, consuming time, and removes inducements for them to loiter encountered on the way.

The attics being well lighted and ventilated can be used for storage of machines of each shop not in use.

The foundation stone walls of these buildings are 3 feet 6 inches wide at the bottom, 2 feet 6 inches at the top, the bases for the central row of iron columns supporting the iron floor stringers being stone columns 3 feet 6 inches square at the bottom, capped with a granite block 18 inches thick and 2 feet square.

The brick walls of basement to the top of the first-floor joists are 24 inches thick; the walls of first story, 20 inches; second story and attic, 16 inches; end walls above cornice, 12 inches, all laid in cement and lime mortar. Rows of cast-iron columns extend longitudinally through the center of basements, first and second floors, supporting the iron stringers which hold the ends of the iron floor-joists, between which are the brick floor-arches.

The roof is a very simple iron truss covered with black Maine slate, secured to the iron purlins by copper nails bent around them. There are no conductors, the water falling to the ground on the flagging surrounding the buildings. Ice and snow fill up the conductors on the old shops and during thaws the roofs often leak badly from water backing up under the slate.

There are iron stairways at the ends and in the centers of the buildings from cellars to attics.

For the milling-shop there are two entrances, to which flights of granite steps lead from the quadrangle, one at the west end and one at the center, the central entrance being through the front transept, by the offices, and having a portico like the old shops with a double flight of steps. For the carpenter and stocking shop, in addition to similar entrances, there is one also at the east end. The style of architecture of these buildings is the simple quaint one of the old shops and arsenals. No expenditure has been made for appearance, but everything possible for the good of the work to be done in them and for the workmen, yet they present not an unimposing appearance, which will be greatly added to when the third building is completed with its front transept, the engine-room, in the center of the quadrangle facing the street. This quadrangle is to be improved with stone carriageways, walks, turf, plants and flowers, adding to the beauty of the city and attractiveness of the armory.

MILL RIVER SUSTAINING-WALLS.

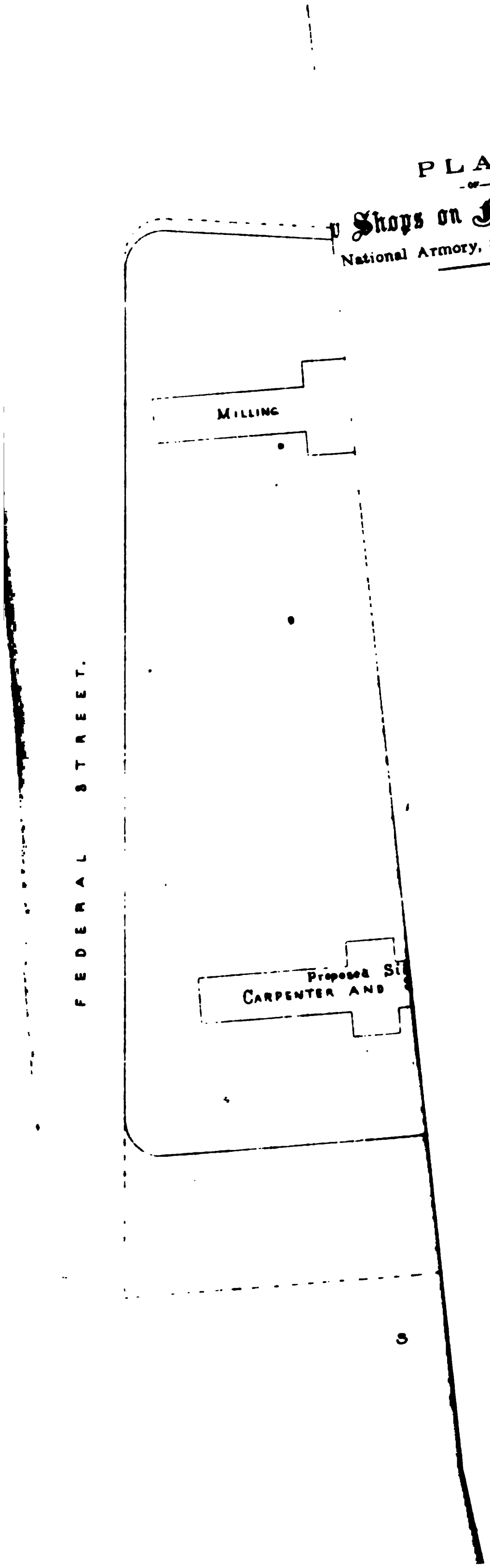
Below the water shops' dam high sustaining walls for about 436 feet are necessary for the Mill River banks. These walls, built some thirty-four years ago, had become so injured by the disintegration of much inferior stone, particularly in the lower layers, as to endanger the stability and the work of rebuilding was begun several years ago. About 256 feet have been completed, on one side, to July 1, 1889—200 feet during the fiscal year.

A. R. BUFFINGTON,
Colonel, Ordnance Department, U. S. Army, Commanding.

PLATE I.

PLAN
-OF-
p Shops on Federal Square,
National Armory, Springfield, Mass.

January, 1888



Approved by the Secretary of War
May 12. 1888 S. V. Benét
Brig. Genl. Chief of Ordnance

Appendix 31. 1888

PLATE II.

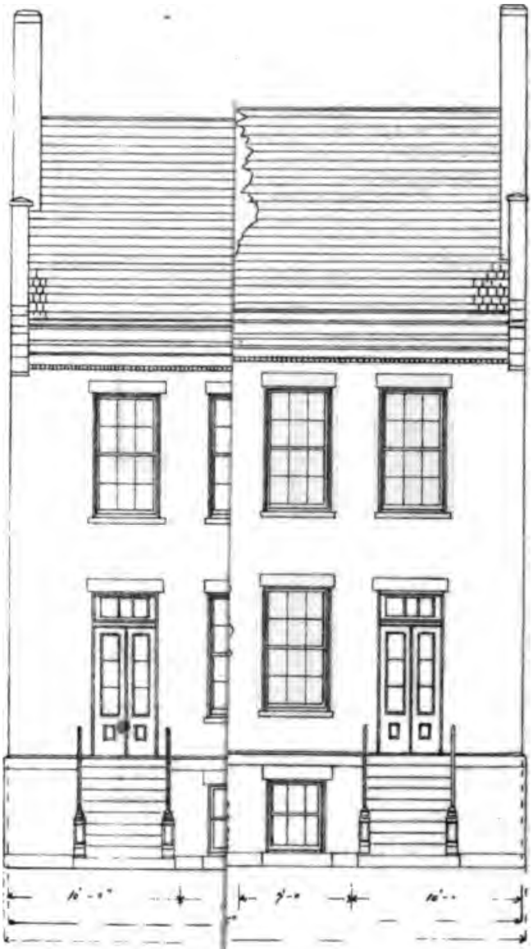
RONT ELEVATION

—OF—

er and Stocking Shop,

ial Armory, Springfield, Mass.

January, 1888.



Approved by the Secretary of War
May 12, 1888.

S. V. Benét
Brig. Gen. Chief of Ordnance.

Appendix 31, 1888.

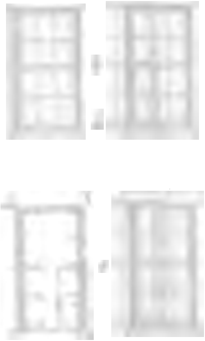


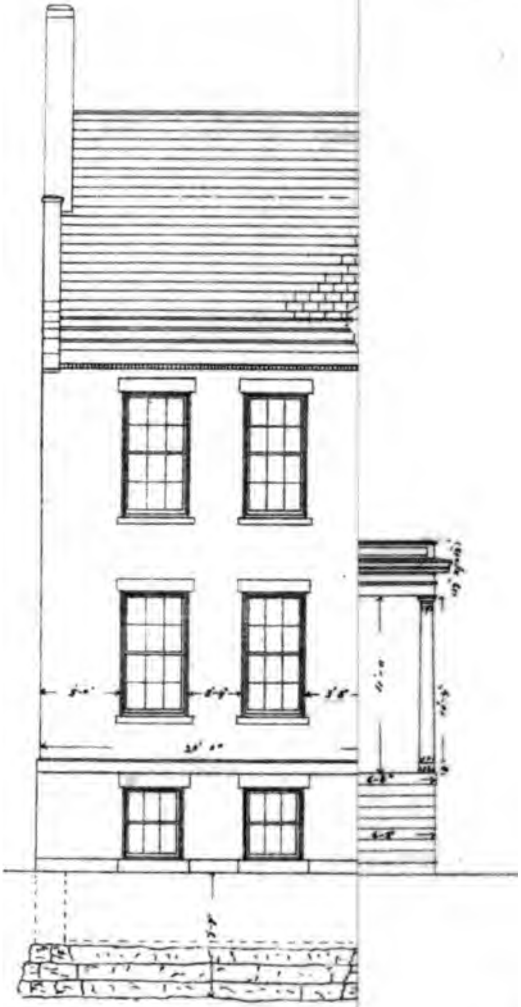
PLATE III

EVATION

Stocking Shop,

Springfield, Mass

January, [illegible]



Approved by the Secretary of War
May 12. 18
S. V. Benét
Brig. Gen. Chief of Ordnance

Appendix 31, [illegible]

PLATE IV.

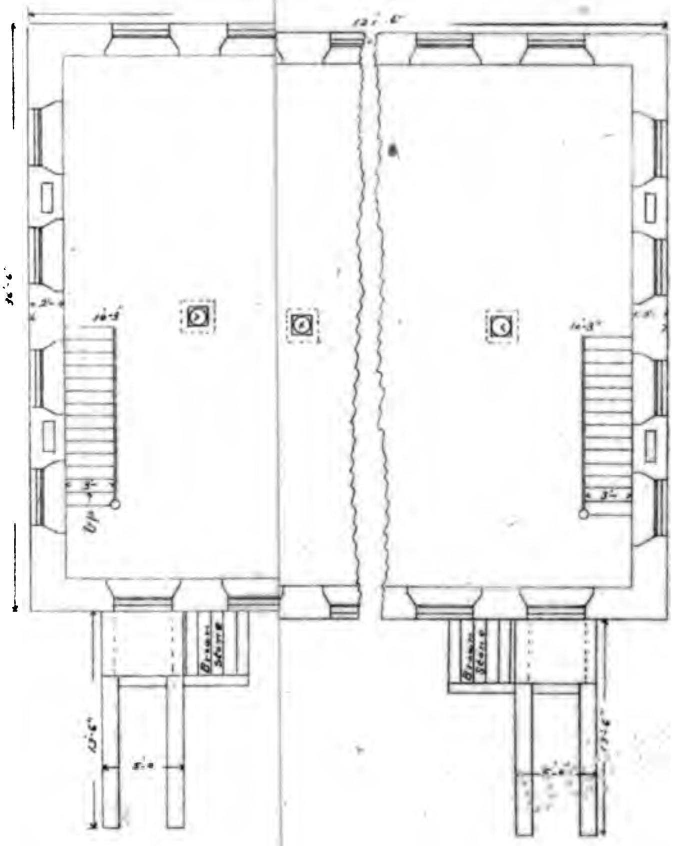
PLAN OF BASEMENT

— OF —

rpenter and Stocking Shop,

National Armory, Springfield, Mass.

January 1888.



Approved by the Secretary of War
May 12. 1888

S. V. Benét
Brig. Genl. Chief of Ordnance

Appendix 33, 1888.

PLATE V.

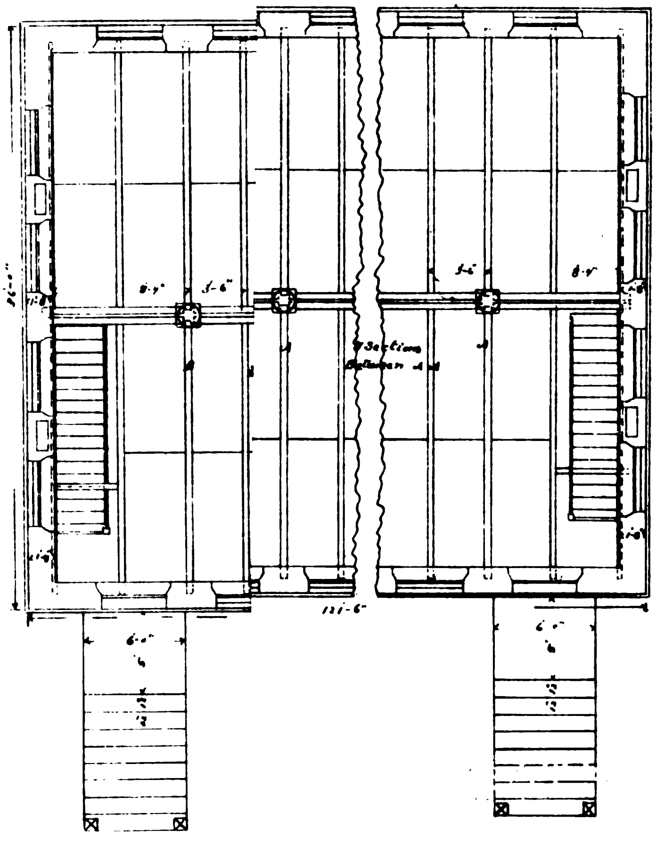
PLAN OF FIRST FLOOR

OF

Carpenter and Stocking Shop,

National Armory, Springfield, Mass.

January, 1880.



War51 1

Approved by the Secretary of War
May 12. 1880

S. V. Benét
Brig. Gen. Chief of Ordnance

Appendix 31, 1880.

PLATE VI.

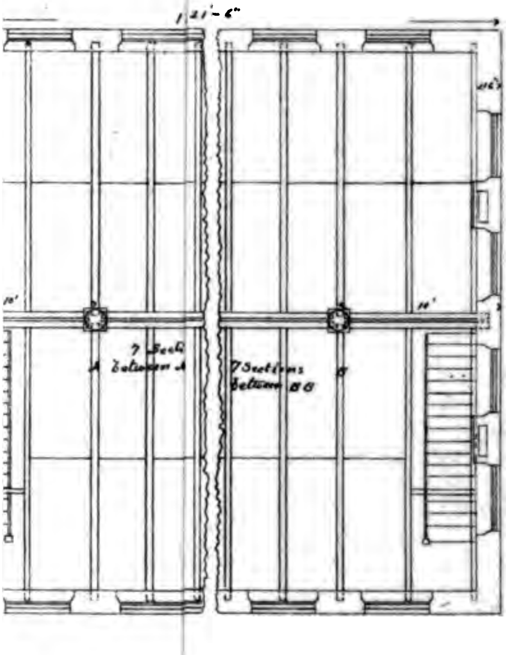
AN OF SECOND FLOOR

OF

er and Stocking Shop,

nal Armory, Springfield, Mass.

January, 1880.



U of M

Approved by the Secretary of War
May 12, 1880

S. V. Benét
Brig Gen Chief of Ordnance

Var51

Appendix 31. 1880.

PLATE VII.

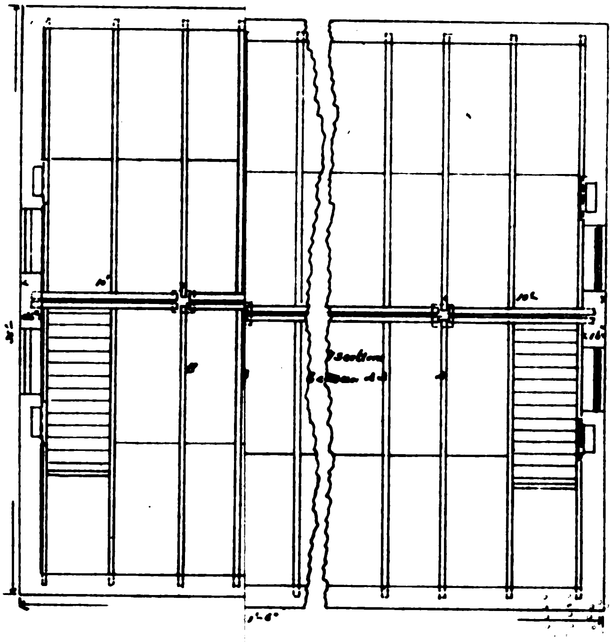
PLAN OF ATTIC FLOOR

—OF—

enter and Stocking Shop,

ational Armory, Springfield, Mass.

January, 1888.



Approved by the Secretary of War
May 12, 1888

S. V. Benét
Brig. Gen. Chief of Ordnance

War51 1

Appendix 31, 1888.

PLATE VIII.

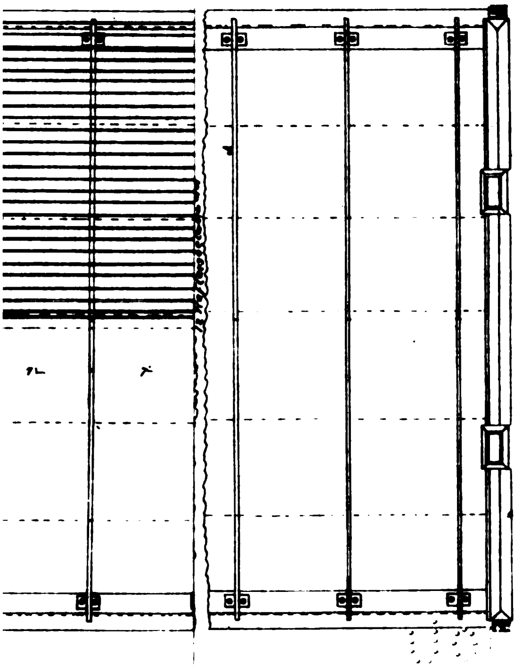
PLAN OF ROOF

OF

ter and Stocking Shop,

nal Armory, Springfield, Mass.

January, 1868.



Approved by the Secretary of War
May 12. 1868.

Brig Genl Chief of Ordnance

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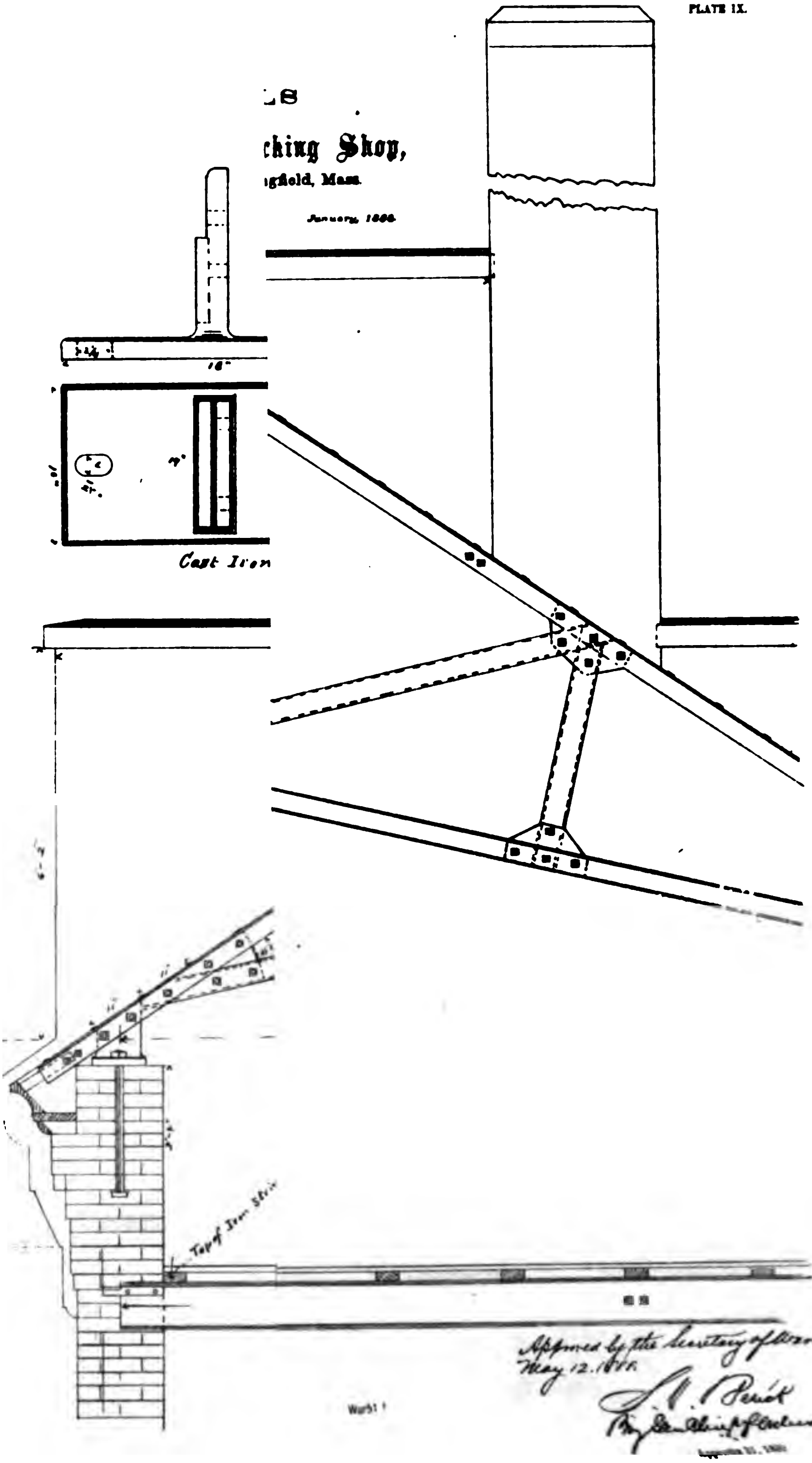
Appendix 31 1869

PLATE IX.



Approved by the Secretary of War
May 12. 1880.

S. V. Benét
Brig. Gen. Chief of Ordnance

PLATE X.

DETAILS
OF
# enter and Stocking Shop,
ational Armory, Springfield, Mass.

January 1886

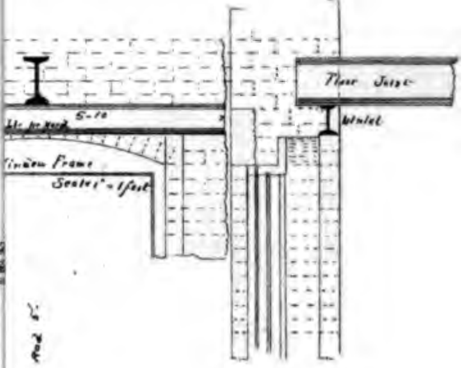
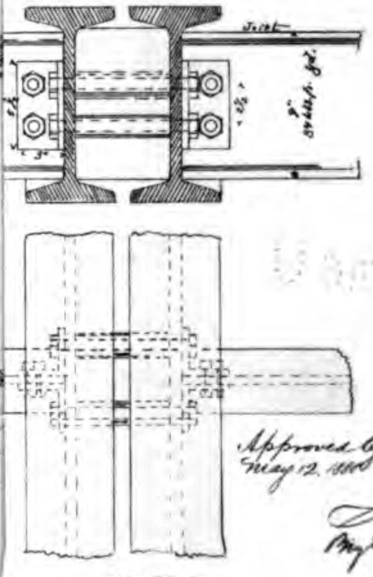


Fig. 4
Section through A. B. Fig. 1
Scale 3" = 1 foot

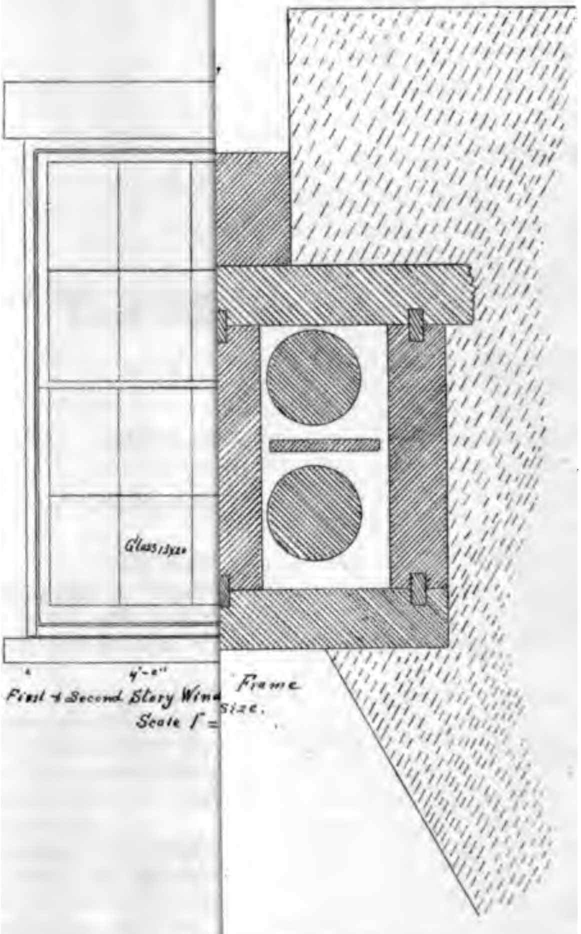


Approved by the Secretary of War
May 12, 1886

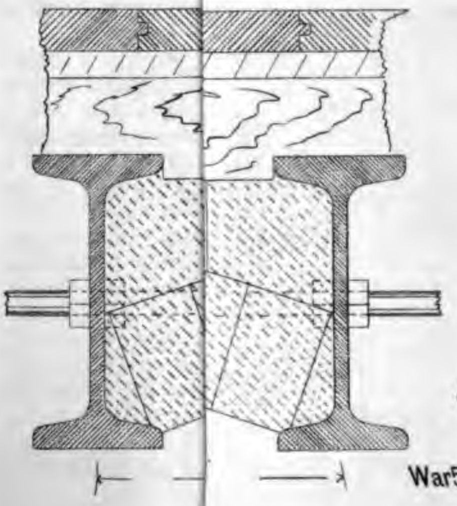
S. V. Benét
Brig. Genl. Chief of Ordnance

War51 1

Appendix 31, 1886.



First & Second Story Wind Frame
Size.
Scale 1" =



Approved by the Secretary of War
May 12, 188

S. V. Benét
Brig. Gen. Chief of Ordnance

Appendix 21, 1888.

War51 1

APPENDIX 32.

PORT ON THE CONSTRUCTION OF BATTERY AT THE NEW YORK STATE CAMP GROUND, PEEKSKILL, N. Y.

(3 plates.)

NEW YORK ARSENAL,
GOVERNOR'S ISLAND, NEW YORK HARBOR,
New York City, *September* 14, 1889.

he CHIEF OF ORDNANCE, U. S. Army,
Washington, D. C.:
(Through the commanding officer).

SIR: Referring to instructions contained in letter of July 31, 1889, m the Ordnance Office, in regard to battery at New York State mp of instruction near Peekskill, I have the honor to submit the following report:

On receipt of original order from the Ordnance Bureau in regard to is battery, a letter was addressed to the governor of the State of ew York stating that his application for its construction at the State amp had been approved by the War Department and that I had been irected to do the work; also requesting that I might be informed as to he proposed site.

As a result of this letter, on May 6, 1889, Major-General Porter, Adutant-General, Brigadier-General Varian, chief of ordnance of the tate, and myself proceeded to the State camp ground near Peekskill, here a site was selected. This was on a plateau about 100 feet above nd looking down the river, which at this point makes nearly a rightngle bend. The control of the river is limited by another abrupt bend elow to about 4 miles. The plateau at its front breaks sharply own to a marsh at near the water's level. Between the left flank of he battery and the edge of the plateau a drive-way of about 20 feet as left. This space is somewhat increased in front of the right flank, s the edge of the plateau curves around to the front and left so as to ace the town of Peekskill. On the right flank room for the drive-way as left between it and a deep ravine leading to the river.

It was thought that a right-line battery would be desirable and that it ould be preferable to have the pieces at right angles to its front, as heir axes would ordinarily be over the axes of the platforms and the hances of settling of the latter would be diminished. In order that he battery should always be dry it was decided to place it on the ground evel and to provide earth for the parapet by digging a ditch in front. he profile shown in Plate I was adopted. The work was begun by carefully laying out the principal lines on the ground with a transit, and hen erecting profiles at the middle of the front of the parapet, at the ntersection of the front with each wing and at the outer extremities he wings. Shovelers were placed at the right wing, the mortar bat-, and while work was progressing there a plank revetment was be-constructed in front of the gun-battery. This was made of 4-inch ow pine planking and 8-inch posts, each post being tied to another rt post or anchor within the parapet. It is thought that it should a number of years without repair. It extends in front of the guns around the magazine. The magazine was built of yellow pine and artly above and partly below the ground level. The storage room powder is 10 by 12 feet and the loading and implement room 10 by eet. Each room is ventilated by two 5-inch cast-iron pipes. Slides heir inner openings enable them to be closed whenever the external is damper than that within. Both rooms are ceiled throughout. y are floored with plank, which in turn is covered with a narrow gued and grooved flooring of yellow pine.

he external planking is 4 inches in thickness. It was first covered h heavy tarred felt paper, the roof receiving in addition a coat of halt. The soil was a very sandy one, but in digging the ditch a layer of clay or loam was passed through. This was removed and served, and was finally used to give a thickness of 1 foot or more nediately adjacent to the sides and on top of the magazine, and also ace the slopes of the parapet and ditch. Sand, gravel, etc., as dug, e used to fill in with afterward. The magazine was covered with a kness of 4 feet and its sides were protected with 5 feet of earth. ts rear was faced with 4-inch planking. Steps were placed at each of the doorway to afford convenient access from both gun and tar batteries. Whenever the side revetment and rear-face planking w signs of decay the earth slopes of the top-covering may be pro-ged to the ground, the only modification required being the replac- of the side steps by a single pair directly in front of the door. The etment about the magazine is in nowise indispensable, but serves to a finish to the whole.

he platforms for the mortars were made at the U. S. Watertown enal and are of the usual pattern. Those for the guns were made he ground. They are rather larger and heavier than absolutely essary. They were so made to cover a large area and thus prevent ling; also to admit of traversing the guns through a very large

As arranged, the firing may be down the river; into the face of nd hill near the water's edge and a little to the right and front of right flank of the battery; to the right of this hill across the river the Dunderberg Mountain, and still farther to the right into the ge bounding the northerly and westerly side of the camp ground.

line of fire down the river crosses the line of the New York Central Hudson River Railroad, but well above it; that across the river the Dunderberg Mountain crosses this road and the West Shore in ition. The platforms were planked throughout. When those por-s of the planking not under the rear traverse-rail decay they need of necessity be renewed, but may be replaced by an earth covering.

building the parapet the earth was first thrown up by shovels, but he ditch increased in width and depth and the parapet in height, k runs were made and the earth was moved in wheelbarrows. This ed expeditious, and, had not an exasperating delay occurred in pro-ng suitable lumber for platforms and for constructing the magazine, entirely to the contractor, the whole battery could have been com-ed in thirty days. As it was, double that time was taken. The k was all carefully done. The slopes of parapet and ditch were d with clay or loam. This was rammed hard, as was the entire parpet. To prevent washing, both parapet and ditch were sodded throughout. The soil was very poor. The sod was therefore cut at least 4 inches thick. Its edges were well driven together and the whole thoroughly beaten down. It was secured on the slopes by wooden pegs about 10 inches long, each sod receiving at least one. As the grass was not particularly thick it was seeded and fertilized. It was also watered for a few evenings after the sod was laid until copious rains began to fall, when a fine sward was developed.

The ditch of course had no other function than to supply earth for the parapet, but all lines and angles were laid out with as much care as would be exercised in constructing the moat of a permanent work. To drain it a slight inclination was given it from left to right, and from the latter extremity an 8-inch drain-pipe was led to a deep ravine 30 or 40 feet away. The area at entrance to magazine was drained by a pipe leading to the bluff in front of the battery.

The revetment was painted an olive green. The guns, mortars, and mortar beds were scraped; the carriages and beds were painted, and the guns and mortars relackered.

The total cost was about $3,400. This includes cost of tools, transportation of guns, carriages, mortars, mortar-beds, tools, and materials from New York to State dock at Roa Hook, hauling from dock up long hill to camp ground and return of tools to New York Arsenal, leaving net cost of battery at about $3,000. This last sum includes cost of iron-work, about $525 for pintles, pintle-plates, traverse rails, front and rear, etc.

With my present knowledge as to cost of handling earth, cutting sod, and hauling it from a distance, and of laying it, lumber would not be used in building revetment, facing magazine, etc., but cut stone would be used instead. Lack of that knowledge and the possibility that the appropriation might be exceeded induced me not to attempt the more expensive but permanent construction.

Plates I, II, and III give full information as to plan and details of battery.

Very respectfully, your obedient servant,

JOHN E. GREER,
Captain Ordnance Department, U. S. Army.

PLATE I.

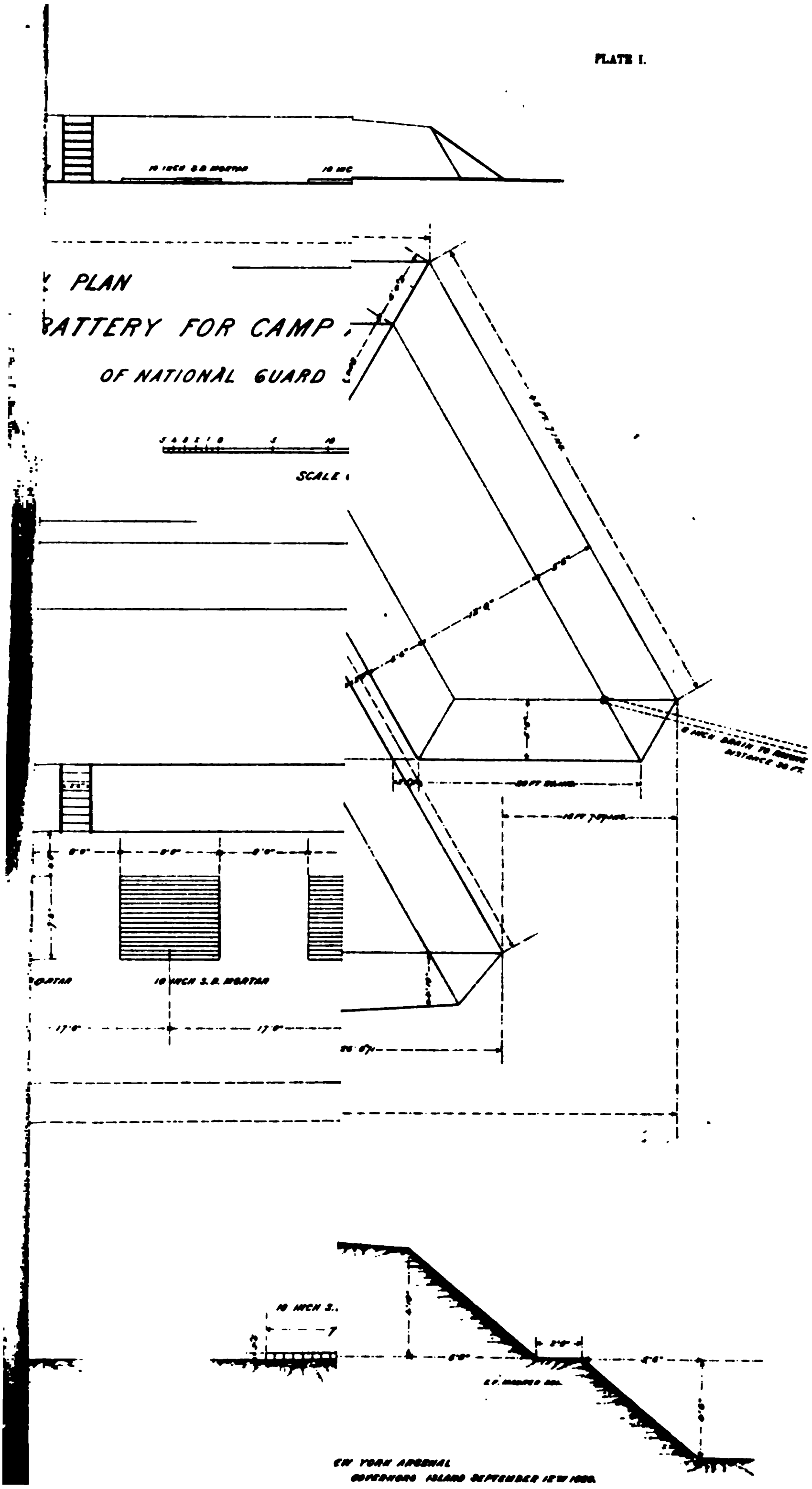

10 INCH S.B. MORTAR
10 INC
PLAN
BATTERY FOR CAMP
OF NATIONAL GUARD
SCALE
8 INCH DRAIN TO RAVINE
DISTANCE 30 FT.
8'0"
8'0"
8'0"
MORTAR
10 INCH S.B. MORTAR
17'0"
17'0"
10 INCH S.
EW YORK ARSENAL
GOVERNORS ISLAND SEPTEMBER

PLATE I.

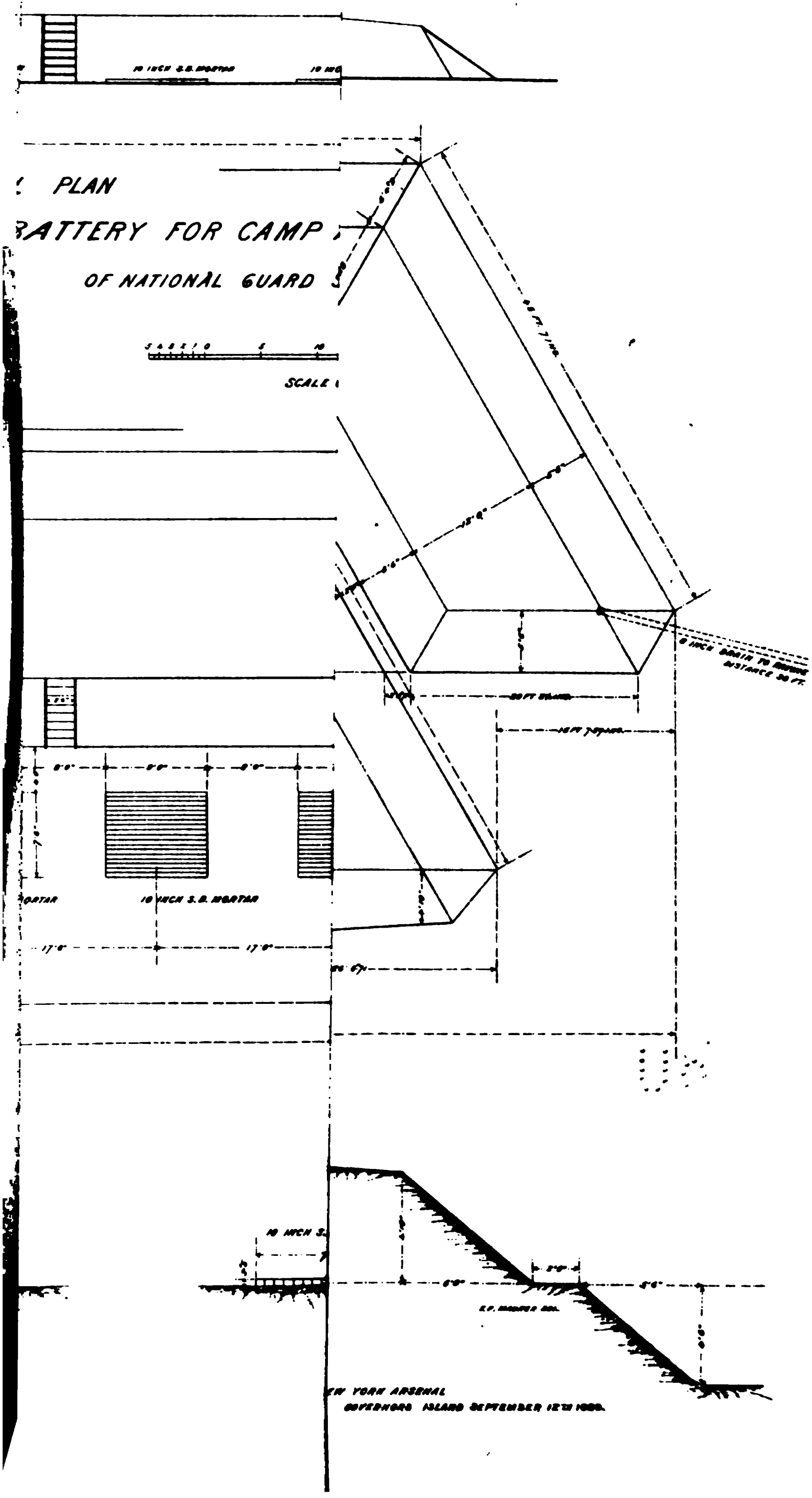
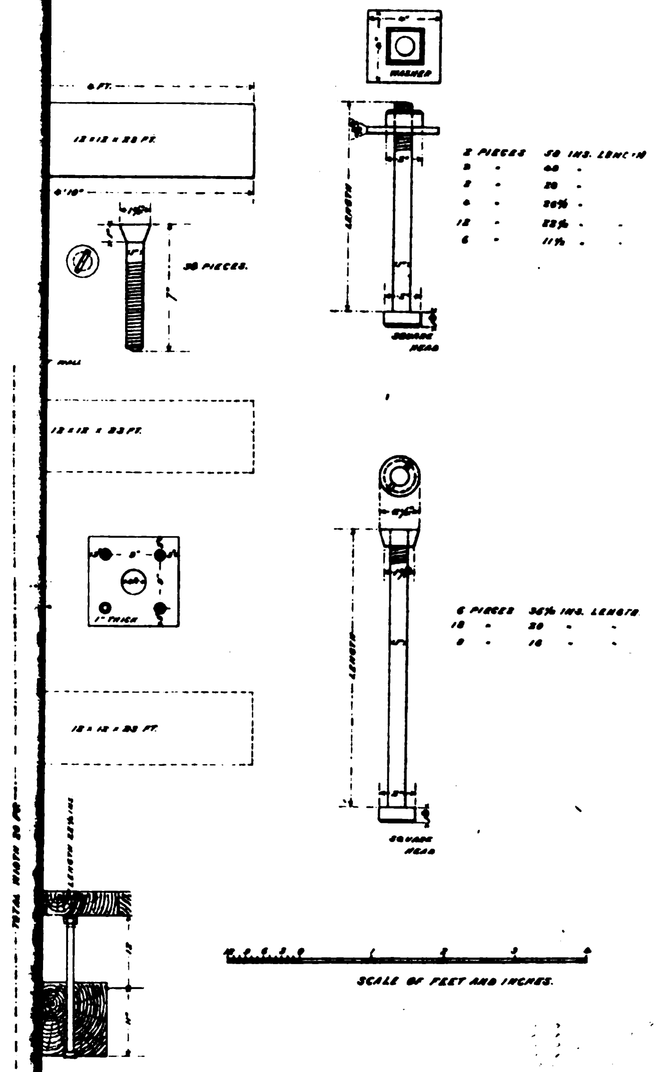

10 INCH S.B. MORTAR
10 INC
PLAN
BATTERY FOR CAMP
OF NATIONAL GUARD
5 4 3 2 1 0 5 10
SCALE
6 INCH DRAIN TO
DISTANCE 30 FT.
6'0"
17'0"
17'0"
10 INCH S.B. MORTAR
ORTAR
10 INCH S.
E.P. MAGUIRE ASST.
NEW YORK ARSENAL
GOVERNORS ISLAND SEPTEMBER 12TH 1888.

PLATE III.



TAILS OF PLATFORMS

FOR 10 INCH RODMAN S.B. GUNS.

BATTERY FOR CAMP AT PEEKSKILL

OF NATIONAL GUARD STATE OF NEW YORK

War51 1

NEW YORK ARSENAL
GOVERNORS ISLAND SEPTEMBER 12TH 1888.

Appendix 32, 1889

APPENDIX 33.

PORT ON THE CONSTRUCTION OF A 12-INCH CAST-IRON MORTAR (EX-PERIMENTAL) FABRICATED BY THE SOUTH BOSTON IRON WORKS UNDER SECTION 6 *OF THE ACT OF SEPTEMBER* 22, 1888.

(1 plate.)

FIRST CONSTRUCTION REPORT.

By CAPT. D. A. LYLE, Ordnance Department, U. S. Army.

This 12-inch B. L. R. cast-iron mortar is being made by the South
ston Iron Works under the act of Congress, approved September 22,
88, for submission to the Board on Ordnance and Fortification, for
periment and test. The castings were made muzzle down, and the
terior is left just as it leaves the mold, without any turning or finish-
g other than dressing off any rough spots that appear. The breech
echanism is to be the French screw fermeture with De Bange gas
eck.

INSTRUCTIONS.

Under date of November 13, 1888, the Chief of Ordnance sent Captain
yle the following instructions relating to this mortar, viz:

> In addition to your other duties as inspector of ordnance at the South Boston
> undry, you will act as inspector of a 12-inch B. L. cast-iron mortar, to be made and
> rnished for test by the South Boston Iron Works, under the provisions of section 6
> the act approved September 22, 1888, copy herewith. In the performance of your
> ty under these instructions the following recommendation of the Board on Ord-
> nce and Fortification, which has been approved by the Secretary of War, is fur-
> shed for your guidance, "that the inspector be instructed to so inspect the mortar
> to enable the Board to determine to its satisfaction whether it be equal in material
> d workmanship to the 12-inch cast-iron steel-hooped breech-loading mortar now
> Sandy Hook."
>
> You will accordingly take such steps in relation to tests, etc., as will enable you
> fully meet the requirements of the Board. You will please inform the company
> at you have been designated for this duty, and that you are prepared to perform it
> henever the company is ready.

The company was duly notified, and the preparations for casting
ere made.

FIRST CASTING.

The first casting was made November 27, 1888, but was rejected by
e company on December 1, 1888, on account of a crack extending
ugitudinally from end to end, and passing through one side of one
unnion.

Below are given the furnace charge, cooling table, and other data.

FURNACE CHARGE.

Material, Richmond pig-iron (*fide* W. P. Hunt, president company).

Charge.

	Pou
Richmond No. 2	13,
Richmond No. 3	10,
Richmond No. 4	15,
Richmond remelted	20,
Total charge	59,

Fide Mr. Arthur Hunt.

Coal used, about 13 tons Pennsylvania coal (*fide* Mr. Arthur Hunt).

Furnace fires lighted 2.45 a. m. November ber 27, 1888 (*fide* Mr. A. Hunt).

Metal melted, 11.30 a. m. November 27, 1888.

Time of melting, 8¾ hours.

Time in fusion, 4½ hours.

Mortar cast, 4 p. m. November 27, 1888.

Time occupied in casting, 25 minutes.

Temperature water entering core barrel, 40° Fah.

Temperature water leaving core barrel, 70° Fah.

Rate of water per minute, at first, 38 gallons.

Rate of water per minute, after regulated, 22½ gallons.

Fire kindled in pit 4.30 p. m. November 27, 1888.

Fire extinguished November 30, 1888.

Approximate temperature of pit. 2.3 m., November 28, 1888, 190° Fah.

Approximate temperature of pit, a. November 30, 1888, 140° Fah.

Core barrel removed 3 p. m., Novem 28, 1888.

Core barrel removed 23 hours after ca ing.

Water entered gun, 3.15 p. m. Novem 26, 1888.

Rate of water per minute, 10 gallons.

Temperature water entering mortar, Fah.

Temperature water leaving mortar 1 Fah.

Total time of cooling mortar, 71 hours.

COOLING TABLE.

Temperature of water leaving core barrel—hours after casting.*a*				Temperature of water leaving mortar—hours after casting *b*							
Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.
	°		°		°		°		°		°
1	72	13	60	24	138	36	122	48	76	60	59
2	71	14	59½	25	157	37	117	49	75	61	57
3	68	15	59	26	156	38		50	74	62	56
4	66	16	59	27	154	39	109	51	73	63	55
5	64	17	58½	28	150	40	105	52	72	64	54
6	64	18	58	29	149	41	100	53	72	65	53
7	63	19	57	30	144	42	95½	54	71	66	*c*53
8	62	20	56	31	140	43	90	55	69	67	53
9	61½	21	56	32	137	44	82½	56	66	68	53
10	61	22	56	33	134	45	80	57	63	69	53
11	60½	23	*d*57	34	130	46	79	58	60	70	53
12	60			35	126	47	78	59	60	71	*e*51½

a Hydrant temperature 42°, and rate 22½ gallons throughout.

b Hydrant temperature 42° and rate of water 10 gallons per minute throughout.

c Temperature of pit, 140° F.

d Core barrel removed.

e Water shut off.

Started to remove core arbor November 28, 1888, at 3 p. m.

Core arbor out at 3.10 p. m.

n slowly at 3.15 p. m.
ed over, but checked in a few minutes, at 3.25 p. m.
at 3.30 p. m.
re 138° at 3.35 p. m.
re varied from 138° to 130° at 3.35 to 3.45 p. m.
; water, 138° at 4 p. m.
re 158° at 4.10 p. m.
re 158° at 4.30 p. m.
re 157° twenty-five hours after casting at 5 p. m.
No. 1, fracture white crystalline, specks of graphite.
No. 2, fracture earthy, granular.
l, brittle; fracture appears granitic.
used for core arbor wrapping; poor stuff; oil boils up and out; deceptive;
l to belief that arbor leaks.
ting was condemned by the commanding officer at once, and preparations
n for making second casting.

SECOND CASTING.

cond casting was poured December 15, 1888. It was made own, and differed in the cooling from the first in not having arbor wholly withdrawn until after mortar casting was cool. was withdrawn 18 inches after seventeen hours; 36 inches nty-three and one-half hours; entirely out for a few minutes y-five and one-half hours; then put back to 54 inches, where ed until wholly removed, eighty-seven hours after casting.

FURNACE CHARGE.

, Richmond pig (*fide* Mr. Arthur Hunt and Mr. Wm. P. Hunt, president

elted iron was made up of sections of an old 15-inch S. B. Rodman gun th Boston Iron Company.)

Charge.

	Pounds.
No. 2	15,000
No. 3	17,000
No. 4	8,000
	18,000
l charge	58,000

Mr. Arthur Hunt.)

d, about 13 tons Pennsylvania. (*Fide* Mr. Arthur Hunt.)

re lighted 5.30 a. m., December
; *fide* Mr. A. Hunt).
ted, 11.30 a. m.
elting, 6 hours.
sion, 5½ hours.
t, 5 p. m.
pied in casting, 15 minutes.
re water entering core barrel.

re water leaving core barrel,

ater per minute, 18 gallons.
ed in pit at 5.30 p. m.

Fire died out in pit at 6 p. m., December 16, 1888.
Fire in pit burned 24½ hours.
Water shut off at 8 a. m., December 19, 1888.
Core barrel removed at 10 a. m.
Total time of cooling mortar, 87 hours.
Iron hotter, more liquid, and softer than first casting.
Test sticks:
- No. 1, gray, earthy fracture.
- No. 2, mottled.
- No. 3, rather earthy.

COOLING TABLE.

[Temperature of water leaving core-barrel. Hours after casting.]

Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.	Hours.	Temperature.
	°		°		°		°		°		°
1	[a]67	16	55	30	47	45	43½	59	41	74	40
2	66	[b]17	55	31	47	46	43	60	41	75	40
3	63	18	50	32	47	47	43	61	41	76	40
4	62	19	50	33	47	48	43	62	41	77	40
5	61½	20	50	34	47	49	43	[f]63	41	78	40
6	60	21	50	35	46½	50	42½	64	40½	79	40
7	59½	22	48	36	46½	51	42½	65	40	80	40
8	59	23	48	37	46½	52	42	[g]66	40	81	40
9	58	[c]24	48	38	46½	53	42	67	40	82	40
10	58	[d]25	47	[e]39	48	54	42	68	40	83	40
11	57	26	47	40	45½	55	42	69	40	84	40
12	56	27	47	41	45	56	41½	70	40	85	40
13	55	28	47	42	44	57	41½	71	40	86	40
14	55	29	47	43	44	58	41	72	40	[h]87	40
15	55			44	43½			73	40		

[a] Rate of water, 18 gallons throughout.
[b] Core arbor withdrawn 18 inches.
[c] Core withdrawn, 36 inches.
[d] Fire in pit went out.
[e] Hydrant temperature, 38 Fah.
[f] Hydrant temperature, 40 Fah.
[g] Core taken out; bore inspected; cherry-red about trunnions; dark below them; core put back and withdrawn to 54 inches.
[h] Water shut off; core barrel removed.

	Inch
Total length rough (2d) casting (16 feet 2 inches)	19
Riser, or sinking head	4
Diameter sinking head equals diameter of re-enforce	4

Initial tension rings.

Number (one breech and one of muzzle), 2.
Breech:

	Inche
Diameter	44
Length	4
Distance of face from face of breech	5.
Interior diameter	11

The muzzle initial tension ring has not yet been taken.

The company refuse to have any tests of the ring or of the met made until after the firing test. The facts have been reported to t Department in a letter dated January 11, 1889.

Machining.

On December 26, 1888, the casting was in the lathe and turning breech bearing begun. On January 5, 1889, the work was turned ov to my successor, Capt. A. H. Russell, Ordnance Department, U. Army. At that date the condition of the work was as follows:

1. Sinking head with initial tension ring attached cut off.
2. Mortar re-adjusted in lathe.
3. Mortar "rounded" at breech.
4. Mortar bored to 11.5 inches.
5. Mortar bored to 11.75 inches.

ring to 11.5 inches a defect was found near the breech; it was
e workman called a "cold shut." It apparently disappeared in
up to the larger diameters, but no critical examination has been
y me. After boring to 11.75 inches four diametral holes were
near the muzzle to test the eccentricity of the boring. It was
o be about 0.1 inch, and the machine was set to correct the error.
ectfully submitted.

D. A. Lyle,
Captain, Ordnance Dept., U. S. A., Inspector.

ON, Mass., *January* 17, 1889.

SECOND CONSTRUCTION REPORT.

By Capt. A. H. Russell, Ordnance Department, U. S. A.

REPORT.

irst construction report, made by Capt. D. A. Lyle, covers the
January 15, 1889.

mortar was finished March 7, 1889, and inspection was completed
9, 1889.

nterior is made to conform as closely as possible to that of the
B. L. rifled mortar No. 1, hooped with steel, described in Ap-
22, page 253, Report of Chief of Ordnance for 1887. The breech
nism is the same in principle, differing only in the following de-
iz:

face plate is made of bronze instead of steel, without bushings
r axles.

crank for translating screw is made of bronze instead of steel,
thout a joint for folding up the handle.

hinge-block is made of bronze instead of mild steel forged, and
ured to the face of the breech by ribs fitting in horizontal un-
grooves in the face of the breech in addition to the screws before

atch differs only in having the handle bent downward more.

securing latch differs entirely. Instead of being a lever latch,
g on a pin in the face of the breech, and extending through a
the hinge-block, it is a vertical pin, worked by a spiral spring
in a socket in the hinge-block itself.

star-gauging, in tables appended, indicates variations from
d. The diameter of screw-box to top of thread is 14.326 inches
of 14.332 inches of drawing. The diameter of screw to top of
being the same as the standard, the play of breech-screw is
n that prescribed. Instead of making the groove in front of the
n screw-box with a diameter of 15.5 inches, as in the drawing, it
de of same size and curve as in the first drawings for the former

e modified drawings for the former mortar the curved surface
ted in a flat surface extending to .25 inch from the chamber,
of retaining the curve up to the chamber, and the shoulder of
-check seat-gauge was made for the old shape. Consequently,
d not fit in far enough to fill out the gas-check seat, giving the
sion that this part was too large. A templet was made, as a
ute, and no material variation in dimensions and distance from

the face of breech was observed, but the .1 inch radius curve of the rear edge projects to the rear instead of being included in the length, 2.875 inches, given for gas-check seat in drawings for both mortars.

With the exception of the breech-closing apparatus, the mortar is entirely of cast-iron, left, on the exterior, rough as coming from the mold, except where it is dressed at the muzzle, breech, and trunnions.

The drawings call for an exterior diameter of 43.5 inches from a point 12.6 inches from the face of the breech to a point 1.5 inches in front of the axis of the trunnions; but this varies from 43.18 inches towards the rear to 43 inches towards the front, with a marked depression opposite a joint of the mold 22.6 inches from the face of the breech, this mark encircling the piece. A depression .325 inch deep, 2.5 inches lengthwise of the piece, by 4 inches tangentially, appears at a point 13.5 inches from the face of the breech opposite the lower edge of the right-hand lower screw section of the screw-box, and another slight depression 1 by 1 inch, about .125 inch deep appears at a point 12 inches from the face of the breech opposite the upper part of the left-hand lower screw section. At 9 inches from the face of the muzzle another depression encircles the piece.

From near the trunnions the exterior tapers gradually to the muzzle, where measurement gives a diameter of 23 inches instead of 22.5 inches called for by drawing. On account of the roughness of the surface, exact dimensions can not be given.

The trunnions are set at 79.75 inches from the face of the muzzle to give a preponderance of 250 pounds at the face of the breech.

The weights are as follows:

	Pounds
1. Breech-block	70
2. Mushroom head and spindle	147
Weight translated	850
3. Tray	2[illegible]
4. Hinge and rack	7
5. Rack	[illegible]
	1,1[illegible]

Weight of finished piece, 32,380 pounds, 14.85 tons.

Marks.

The mortar is marked upon the face of the muzzle with the following letters and characters, placed in a circle concentric with the bore, viz: 12-IN. B. L. M. S. B. I. W., above, and WT. 14½ TONS, 1889, below. The inspector's initials do not appear, as the piece is not Government property.

The South Boston Iron Works, objecting to the physical test of metal until after the piece had been declared serviceable in the firing tests, breech and muzzle sections of the casting have been set aside, under authority from the Board of Ordnance and Fortification and properly marked for identification in case tests need to be made for comparison with future castings made under the law.

The breech section is a disk 4.375 inches thick, of full size of casting, diameter 43.5 inches, rough on circumference, interior turned to 10.875 inches diameter. It is marked on the riser face

TOP
F.
12 B. L. M.
C. I.
W. P. Hunt, Jr.

his face is smooth to within an inch of the bore, where it was broken
from the body of the casting, in breaking a portion of the interior
g chipped out. The opposite face is smooth.
he exact distance from the face of the breech of the mortar to the
of this disk is not known. It was about 6 inches.
he muzzle piece is the entire muzzle end of the casting from a point
5 inches from the face of the muzzle, but it has had several grooves
in the cylindrical surface, and these will interfere with cutting
dard rings corresponding with the exterior diameter of the mortar
he muzzle. The diameter is 23 inches; length of cylindrical part 10
es. At the front end is a square boss, cast for convenience in turn-

he core-barrel did not extend through to the bottom. The cylin-
al part of core extended to about 2.5 inches from the rear face, and
cavity is bored out to a diameter of 12 inches. A ring of metal next
bore 2 inches thick projects from this face a little over an inch,
re it is broken off irregularly.
he first groove, 2 inches wide and 0.5 inch deep, is cut at a distance of
5 inch from the face, so that the front limit of the groove corre-
nds with the end of the cylindrical part of the core. This leaves
ce for only a 0.625-inch ring on the exterior, and hardly allows full-
gth specimens to be cut for tensile strength. Half an inch farther
s a deeper groove, and beyond that another. Holes 1 inch in diam-
are bored at right angles to each other along diameters of the cast-
. These extend half the width of the first groove. The Ordnance
np is placed near one of these holes, in the groove.
tar-gauge tables are appended, but it is recommended that measure-
its be made at the Proving-Ground for comparison of changes due
iring, as the correspondence of instruments is not known.
xamination of the interior of the bore showed that the defect noted
he first construction report disappeared as the boring progressed.
n star-gauging the rifling between grooves quite a marked change
noted about 18 inches from the face of the muzzle, due, appar-
ly, to the entrance of the second head of the rifling bar.
espectfully submitted.

A. H. RUSSELL,
Captain of Ordnance, U. S. Army, Inspector.

OSTON, MASS., *March* 19, 1889.

Copies of S. B. I. W. drawings of mortar:
o. 1. Longitudinal section and rear view of mortar.
o. 2. General plan of breech mechanism, longitudinal section, and
r view.
o. 3. Details of breech mechanism.

Record of star-gauging 12 inches B. L. C. I. mortar (experimental) before rifling.

[Standard 12 inches.]

Inches from muzzle.	Horizontal.	Vertical.	Inches from muzzle.	Horizontal.	Vertical.	Inches from muzzle.	Horizontal.	Vertical.
Bore:	*Inches.*	*Inches.*	Bore:	*Inches.*	*Inches.*	Bore:	*Inches.*	*Inches.*
72½	12.003	12.004	48	12.003	12.004	23	12.005	12.005
72	12.003	12.003	47	12.003	12.004	22	12.005	12.005
71	12.003	12.004	46	12.003	12.004	21	12.005	12.005
70	12.003	12.004	45	12.004	12.004	20	12.005	12.006
69	12.003	12.004	44	12.003	12.003	19	12.005	12.005
68	12.003	12.004	43	12.003	12.004	18	12.005	12.005
67	12.003	12.003	42	12.004	12.004	17	12.005	12.005
66	12.004	12.004	41	12.003	12.004	16	12.004	12.006
65	12.003	12.004	40	12.004	12.004	15	12.005	12.006
64	12.003	12.004	39	12.004	12.003	14	12.005	12.006
63	12.003	12.003	38	12.004	12.004	13	12.006	12.006
62	12.003	12.003	37	12.004	12.004	12	12.005	12.006
61	12.004	12.004	36	12.004	12.004	11	12.005	12.006
60	12.003	12.003	35	12.004	12.004	10	12.005	12.004
59	12.003	12.004	34	12.003	12.004	9	12.005	12.006
58	12.003	12.004	33	12.005	12.005	8	12.008	12.006
57	12.003	12.004	32	12.005	12.005	7	12.006	12.006
56	12.003	12.004	31	12.005	12.005	6	12.005	12.006
55	12.003	12.004	30	12.005	12.005	5	12.006	12.006
54	12.003	12.004	29	12.005	12.005	4	12.007	12.006
53	12.003	12.004	28	12.005	12.005	3	12.008	12.006
52	12.003	12.003	27	12.005	12.005	2	12.008	12.006
51	12.004	12.004	26	12.005	12.005	1	12.008	12.006
50	12.003	12.004	25	12.004	12.005	0	12.008	12.006
49	12.004	12.003	24	12.005	12.005			

Inches from face of breech.	Horizontal.	Vertical.	Inches from face of breech.	Horizontal.	Vertical.*	Inches from face of breech.	Horizontal.	Vertical.
Shot chamber:	*Inches.*	*Inches.*	Shot chamber:	*Inches.*	*Inches.*	Shot chamber:	*Inches.*	*Inches.*
54	12.086	12.084	41	12.083	12.083	28	12.399	12.400
53	12.083	12.084	40½	12.083	12.083	27	12.399	12.400
52	12.082	12.083	Standard	12.080	12.080	26	12.399	12.400
51	12.083	12.083	Powder chamber:			25	12.399	12.400
50	12.083	12.083	36	12.400	12.399	24	12.399	12.400
49	12.083	12.083	35	12.400	12.400	23	12.399	12.400
48	12.083	12.083	34	12.400	12.400	22	12.400	12.400
47	12.083	12.083	33	12.400	12.400	21	12.399	12.400
46	12.083	12.083	32	12.400	12.400	20	12.399	12.400
45	12.083	12.083	31	12.399	12.400	19	12.399	12.400
44	12.083	12.083	30	12.400	12.400	18½	12.399	12.400
43	12.083	12.083	29	12.399	12.400	Standard	12.400	12.400
42	12.083	12.083						

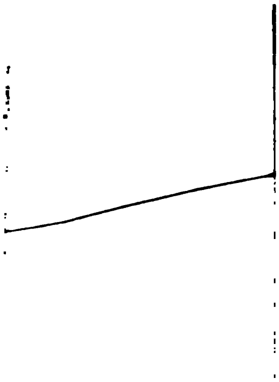
Diameters between grooves in bore and shot-chamber.

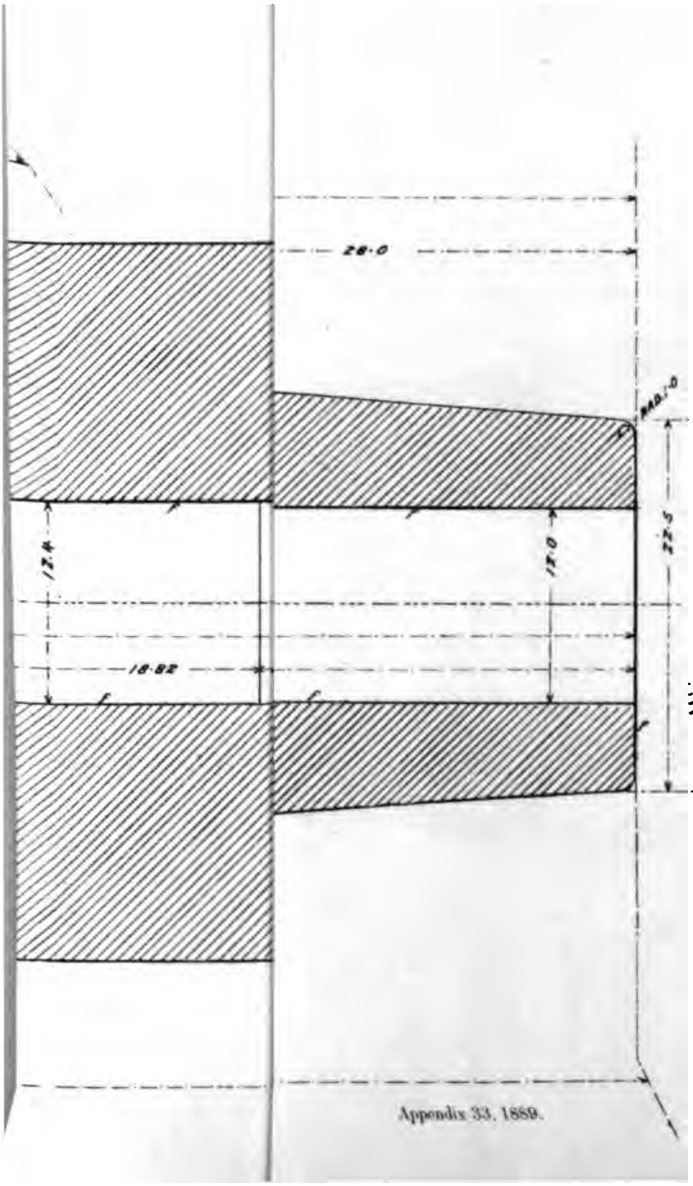
[Standard diameter 12.140 inches.]

from zzle.	Horizontal.*	Vertical.†	Inches from muzzle.	Horizontal.*	Vertical.†	Inches from muzzle.	Horizontal.*	Vertical.†
	Inches.	*Inches.*		*Inches.*	*Inches.*		*Inches.*	*Inches.*
....	12.145	12.138	59...............	12.141	12.137	29...............	12.142	12.136
....	12.144	12.135	58...............	12.141	12.138	28...............	12.142	12.136
....	12.144	12.135	57...............	12.142	12.138	27...............	12.142	12.136
....	12.144	12.135	56...............	12.141	12.137	26...............	12.142	12.136
....	12.144	12.135	55...............	12.141	12.138	25...............	12.143	12.135
....	12.143	12.135	54...............	12.142	12.138	24...............	12.143	12.135
....	12.143	12.135	53...............	12.142	12.138	23...............	12.143	12.136
....	12.142	12.135	52...............	12.142	12.137	22...............	12.143	12.136
....	12.142	12.134	51...............	12.141	12.138	21...............	12.143	12.135
....	12.141	12.135	50...............	12.141	12.137	20...............	12.143	12.136
....	12.141	12.136	49...............	12.141	12.137	19...............	12.143	12.138
....	12.142	12.138	48...............	12.141	12.137	18...............	12.142	12.138
....	12.142	12.138	47...............	12.141	12.137	17...............	12.134	12.141
....	12.142	12.138	46...............	12.141	12.138	16...............	12.135	12.139
....	12.141	12.137	45...............	12.142	12.138	15...............	12.138	12.138
....	12.141	12.136	44...............	12.142	12.138	14...............	12.138	12.138
....	12.141	12.136	43...............	12.142	12.138	13...............	12.137	12.137
....	12.141	12.137	42...............	12.142	12.138	12...............	12.138	12.138
....	12.141	12.137	41...............	12.142	12.137	11...............	12.138	12.137
....	12.141	12.136	40...............	12.143	12.137	10...............	12.137	12.136
....	12.141	12.136	39...............	12.143	12.138	9...............	12.136	12.136
....	12.141	12.136	38...............	12.142	12.138	8...............	12.137	12.136
....	12.141	12.136	37...............	12.142	12.138	7...............	12.138	12.136
....	12.141	12.136	36...............	12.143	12.138	6...............	12.138	12.136
....	12.142	12.135	35...............	12.142	12.137	5...............	12.137	12.136
....	12.142	12.135	34...............	12.142	12.137	4...............	12.137	12.136
....	12.141	12.136	33...............	12.143	12.136	3...............	12.139	12.135
....	12.141	12.136	32...............	12.142	12.136	2...............	12.140	12.137
....	12.141	12.137	31...............	12.142	12.136	1...............	12.140	12.136
....	12.141	12.138	30...............	12.142	12.136	0...............	12.139	12.138

* Guide in groove over number of tons. † Points in groove over number of tons.

PLATE I.





Appendix 33, 1889.

APPENDIX 34.

ALYSIS OF REPORTS ON THE ENDURANCE AND COMPARATIVE MERITS OF THE MORSE AND SERVICE SMALL-ARMS CARTRIDGES.

FRANKFORD ARSENAL,
Philadelphia, Pa., October 28, 1889.

he CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

IR: In compliance with instructions in your letter of the 7th instant, ave the honor to return herewith, with remarks thereon, the reports om fourteen companies on the competitive trial of three kinds of car-idges. viz:

he Morse movable base, brass (pattern 1887).

he Morse movable base, brass (made stronger; pattern prepared at is arsenal in 1888).

he new service cartridge, brass (pattern 1888).

For better comparison, I have as far as practicable collected and put ll useful information contained in the reports on one large abstract bstract A, herewith).

It is a well-known fact that in consequence of different methods em-oyed, and differing care and skill used both in the firing and in mak-g the reports, some reports are of great value, while others are of less lue. It is unfortunate that when abstracted, all affect results equally, d the great value of certain reports is partially destroyed. I espe-lly commend attention to reports marked H and O.

To avoid a false notion of the endurance of the cartridges, it should borne in mind while considering the abstract that 50 cartridges of h kind were tested by each of the fourteen companies, 700 cartridges each kind; and that the reloading was carried frequently to the htieth round and beyond, so that the average number of fires of each ll was about 70, making about 50,000 fires of each kind of ammuni-n, and the total failures in each kind are the failures in about 50,000 es.

The results reported indicate that failures began generally in one or re shells at about the twentieth round.

In my judgment reloading in service should not be carried beyond e twentieth round. It is hardly practicable at posts to detect signs of lures sufficiently well to insure safety. Beyond the twentieth round lures may be expected, though rarely, and cause trouble, and damage e rifle, although most of the shells would still bear 20 to 30 more re-dings. The economy of continuing the reloading beyond the twentieth und is hardly appreciable, and I think the chances of losses and mage from other sources are such that in service the use of the shell uld not generally be carried beyond 20 reloadings, no matter what eir endurance.

Another abstract (Abstract B, to be described further on) is arranged to show the comparative merits of the cartridges at different stages (or numbers of reloadings—rounds) up to the twentieth and beyond.

REMARKS ON ABSTRACT A.

Splits.—These are due to wear and the alternate expansions and contractions caused by firing and crimping. They begin at the mouth of the shell (rarely before the fifteenth round), and extend gradually backward as the reloading is continued. They do not disable the shell for reloading until they reach the base of the bullet, 0.6 inch from the mouth of the shell, though I think reloading should be discontinued after the split has extended 0.4 inch, or better, 0.3 inch. When longer than this they are objectionable in reloading. In the Morse they increase the danger of ruptures near the mouth, and at some point just before they reach the base of the bullet they must permit an escape of gas through the windage of the bullet, until the latter passes into the bore.

The reports show at which round the splits commenced (very rarely before the fifteenth), but do not show at which round they disabled the shell or became very objectionable. In all the firing of the new service cartridge at this arsenal only two shells have been disabled by splits before the twentieth round (one at the seventeenth and one at the nineteenth) and five more before the twenty-fifth.

The abstract shows that the number of splits was practically the same in all three kinds of cartridges. This should be so, since the metal and construction of the shells at the mouth were practically the same. On this account, and also since it is thought the splits disabled the shells rarely if ever before the twenty-fifth round, these splits are not entered on the summary Abstract B, in order that this abstract may furnish a better comparison of the merits of the cartridge as to failures only.

A summary of splits is, however, given on another abstract (Abstract C).

Ruptures.—The ruptures of the Morse shell are of the same kind (that is near the mouth of the shell) which were reported in the trial of this cartridge in 1888. They are much less in the new pattern Morse, especially in the early part of the firing, than in the old pattern, though the improvement in this respect is less than was expected.

The ruptures of the new service cartridge are of the same kind that has occurred in the old copper cartridge (that is, a pulling apart of the body of the shell at about 0.5″ from its base), but the endurance of the shell in this respect is so increased in the new cartridge as to place the time of rupture, as regards number of reloadings, generally beyond any practicable or desirable use of the shell. (The construction of the Morse, its movable base, makes this kind of a rupture practically impossible for that cartridge.)

Summary abstract B shows the number of ruptures with each kind of cartridge up to the various numbers of fires. The record of all three is about the same up to the twentieth round, three being for the old Morse, two for the new Morse, and three for the service. Up to the twenty-fifth round there were twenty for the old Morse, four for the new Morse, and thirteen for the service. This record is more or less accidental, and might be materially changed in a trial of another lot of cartridges. It shows, however, the ability of the service shell to bear twenty-five reloadings, which was all that was hoped for, and also a better endurance of the new Morse than the old up to the point where the metal should n to fail, which was also hoped for. After the twenty-fifth round service began to fail, as was expected, in a way that the Morse ld not, because of its movable base.

s regards the two kinds of failure, that of the Morse is much the e objectionable and dangerous, because of the liability that the ll piece may be carried into the bore and not be noticed before reling, and of consequent damage to the rifle. It is improbable that pture of the service shell would not be noticed in extracting the l, and the only damage should be the delay of extracting the head- shell.

he important point is that the ruptures were practically immaterial ll three kinds before the twentieth round.

ead failures.—These are from broken pockets and cracked and en heads, and are all embraced in one column on abstract A.

f these there were no failures in the service shell before the twenty- round, and only 7 before the fiftieth round.

the old Morse there were 16 before the twentieth round, 21 before wenty-fifth, and 29 before the fiftieth.

the new Morse there were 20 before the twentieth round, 24 before wenty-fifth, and 53 before the fiftieth.

se failures not only disable the cartridge but permit an objection- if not dangerous escape of gas to the rear.

-check faults.—These are of course confined to the Morse cartridge. formation contained in the reports in regard to them is condensed stract A, but they are not included in summary abstract B, as the is intended only for failures, and for a comparison of failures on to all three kinds of cartridges.

ABSTRACT B.

this abstract is given a summary of the two kinds of failures h disable the shell, viz, ruptures and head failures. In conse- nce of the absence of head failures in the service and the large bers of these in the Morse, the summary record of disabling failures uch worse for the latter at all stages of the reloading up to near fiftieth reloading.

GENERAL REMARKS.

p to a desirable or reasonable number of reloadings the number of tures was about the same in all three kinds of cartridges.

fter the twenty-fifth reloading, in consequence of the movable base he Morse patterns, the ruptures of the service pattern increased e rapidly than in the Morse patterns.

p to a desirable or reasonable number of reloadings (20) the head ures of the service were unimportant while there was a large num- in both the Morse patterns.

p to the twentieth reloading, the total failures (both ruptures and d failures) of the service pattern were about 15 per cent. and at the nty-fifth round about 38 per cent. of those of the Morse patterns. the fiftieth reloading they were about the same in all three patterns.

n addition to the above, the relative merit of the two kinds of car- ges, the Morse and service, is further affected by the greater cost the Morse; its more complete construction; greater care and time uired for cleaning and reloading; some failures of gas-checks; and liability of the latter to deteriorate with long storage.

I think much weight should be given to the opinions of the officers who made the trials and watched all the operations connected therewith. Attention is invited to the fact that every officer who expresses an opinion on the comparative merits of the two cartridges gives preference to the service cartridge.

Some of the reports are very strongly in favor of the new service cartridge and its merits, as compared with the old service cartridge.

The following computation gives approximately the total failures of the service cartridge with the numbers of fires at various reloadings.

The new service cartridge.

With 15 reloadings, about 10,500 fires; no failures.
With 18 reloadings, about 12,600 fires; 1 failure.
With 20 reloadings, about 14,000 fires; 3 failures.
With 25 reloadings, about 17,400 fires; 13 failures.

In view of rather indefinite complaints sometimes received in regard to cartridge primers, I would invite attention to the fact that in all this firing, probably about 150,000 fires, only 2 primers are reported to have failed on the first fire.

Very respectfully, your obedient servant,

D. W. FLAGLER,
Lieut. Col., Ordnance Dept., U. S. A., Commanding.

APPENDIX 35.

PORT OF A BOARD OF ORDNANCE OFFICERS ON LOCATION OF THE ARMY GUN FACTORY.

[Extract.]

CIAL ORDERS,
No. 65.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, March 21, 1887.

* * * * * * *

By direction of the Secretary of War a Board of Ordnance Officers to consist of . Col. D. W. Flagler, Lieut. Col. Alfred Mordecai, Lieut. Col. Francis H. Parker, Capt. Rogers Birnie, jr., recorder, will convene at the Watertown Arsenal, Massa-tts, at 10 o'clock a. m., on Tuesday, March 29, 1887, or as soon thereafter as icable, and proceed thence to the Watervliet Arsenal, New York, and the Frank-Arsenal, Pennsylvania, under special instructions from the Chief of Ordnance, after having completed their duties will rejoin their respective stations. The l enjoined is necessary for the public service.

* * * * * * *

By command of Lieutenant-General Sheridan.

R. C. DRUM,
Adjutant-General.

Official:
J. C. KELTON,
Assistant Adjutant-General.

The following are the instructions from the Chief of Ordnance:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., March 25, 1887.

eut. Col. D. W. FLAGLER,
Ordnance Department, President of Board:

SIR: I have the honor to inclose, herewith, Special Orders No. 65, tailing you as President of a Board of Officers to meet at Watertown rsenal on the 29th instant, or as soon thereafter as practicable, and proceed from there to the Watervliet and Frankford Arsenals under ecial instructions from the Chief of Ordnance.

The Board will act under the following instructions:

1st. The Board will make a careful examination of the machinery, ols, motors and appliances at the arsenals named, now used, or which ay be used in the manufacture of cannon, whether field, siege, or sea-ast, and submit their recommendations for the concentration of such rtion thereof as may appear necessary and judicious at either Water-iet or Frankford Arsenal as the Board shall determine. It is the in-ntion of the Department to concentrate its available gun plant at one ace, believing that such policy will inevitably result in economy and ficiency of manufacture, and probably in the steady growth of an tablishment that may ultimately prove adequate for the manufacture experimental guns, and service guns to a limited extent.

The guns that the Department has now under manufacture or conemplates manufacturing during the present and the next fiscal year are as follows:

Twenty-five 3.2-inch breech-loading field guns, steel (see inclosed design). The orgings for these guns are now under contract, and deliveries will begin within the next three months.

One experimental 5-inch B. L. siege rifle, steel (see design inclosed), now underfabrication at the Watertown Arsenal.

One experimental 7-inch B. L. howitzer, steel (see design herewith), the forgings for which are now ready for manufacture of the piece.

One experimental 8-inch B. L. rifle, steel, and one experimental 10-inch B. L. rifle, steel (see plans herewith). The forgings for these two guns will be delivered within the next two months.

2d. The Board will report the probable cost of the installation of this plant at the arsenal selected, and also what additional tools and appliances, with the cost thereof, are necessary for the manufacture of the above experimental guns, and for the manufacture of at least twenty-five 3.2-inch field guns per annum.

All that it is expected to accomplish at present is the bare completion of the guns in the least expensive way practicable, as regards plant and facilities.

The Board will make such recommendations in regard to the proposed work as may be suggested from their examinations; and they will also consider the transfer of skilled employés from Watertown.

3d. The Board will visit the Watervliet and Frankford Arsenals for the purpose of determining from a careful personal examination which arsenal possesses the greater advantages and the best existing facilities for the effective and speedy establishment of the plant in question. In the determination of this question they will have due regard to its adaptability for ultimate development into a fully equipped gun factory. A provision for such an establishment was embodied in the fortifications bills in both houses of Congress and in conference last session, the Watervliet and Frankford Arsenals being the only sites considered by Congress.

The Board will therefore keep such ultimate object in view, and will determine which of the two sites named, Watervliet or Frankford, is on the whole best adapted for the purpose—from the character and extent of the shops and appliances that would be required; from buildings already erected at either point; from the proximity of the place to the establishments that will probably furnish the material to be worked; its security against hostile operations; its facilities as regards transportation of material and guns both by water and rail; its proximity to the centers of skilled labor; manufacturers' supplies and fuel.

Facilities for a proof-butt, convenient to the works, for firings incidental to the manufacture—as the setting out of lining tubes of guns—are a desideratum, and if practicable at either point should receive due consideration.

A full and detailed report is required on these various points, based on facts personally known to the Board, or which may be developed by their investigations, in order to show clearly the reasons that have guided the Board in determining on the arsenal selected as the most suitable for the purposes herein contemplated.

The report of the Gun-Foundry Board, with supplement, 1884, and the report of the House Committee on Ordnance, first session Forty-ninth Congress, 1886, are forwarded herewith for the information of the Board.

Respectfully, your obedient servant,

CHAS. S. SMITH,
Captain, Ordnance Dept., U. S. Army,
Acting Chief of Ordnance.

NEW YORK ARSENAL, N. Y.,
May 14, 1887.

The Board convened at the Watertown Arsenal, Mass., on the 29th day of March, 1887, in compliance with the foregoing orders, and afterwards proceeded to the Watervliet and Frankford Arsenals as necessary to comply with the instructions of the Chief of Ordnance. Having completed its work at the three arsenals named, and in order to give the members time to procure and arrange further information and make estimates, the Board adjourned at the Frankford Arsenal on the 15th day of April, 1887, to re-assemble at the New York Arsenal, N. Y., upon the call of the president of the Board on May 2, 1887, or as soon thereafter as practicable, subject to the approval of higher authority.

The Board re-assembled at this (New York) Arsenal on the 3d day of May, 1887, for the purpose of completing its report, pursuant to the following order:

[Extract.]

SPECIAL ORDERS, No. 93.

HEADQUARTERS OF THE ARMY,
ADJUTANT GENERAL'S OFFICE,
Washington, April 22, 1887.

* * * * * * *

1. By direction of the Secretary of War the Board of Ordnance Officers appointed by Special Orders, No. 65, March 21, 1887, from this office, will re-assemble, on the call of the president thereof, at the New York Arsenal, N. Y., for the purpose of completing its report, and upon the completion of this duty the members of the Board will rejoin their respective stations. The travel enjoined is necessary for the public service.

* * * * * * *

By command of Lieutenant-General Sheridan.

R. C. DRUM,
Adjutant-General.

Official:
J. C. KELTON,
Assistant Adjutant-General.

REPORT.

It is understood by the Board that the object of the Chief of Ordnance, as set forth in his letter of instructions, is to build up a fully equipped gun factory as rapidly as possible.

To this end he designs to concentrate, at the place which may be selected for the gun factory, all the available gun-plant now on hand, or to be procured, and all the gun fabrication contemplated by the Department.

The duty assigned to the Board is to determine which of the two arsenals, Watervliet or Frankford, furnishes the better site for the fully equipped gun factory; to estimate the cost of concentrating at the arsenal selected all the machines and appliances suitable for the gun plant now on hand at the two aforementioned arsenals and at Watertown; and also the cost of adding to the above plant enough machines and appliances to make the capacity of the whole sufficient for manufacturing—

One experimental 5-inch B. L. siege rifle, steel; 1 experimental 7-inch B. L. howitzer, steel; 1 experimental 8-inch B. L. rifle, steel; 1 experimental 10 inch B. L. rifle, steel; and also for manufacturing 25 3.2-inch B. L. field guns, steel, per annum.

In carrying out the above instructions the Board has determined, first, the cost of concentrating at each of the arsenals named the machines and appliances now on hand suitable for a gun plant; and second, the cost of procuring and installing at each arsenal the *additional* machines and appliances required.

The Board first prepared lists of the machines, tools, and appliances required for performing the specified work; it then determined which of the machines, etc., on hand at the three arsenals mentioned could be used advantageously in lieu of those required; and also the cost of transferring these machines, etc., to, and installing the same at, each of the arsenals proposed for the gun factory. It next determined the cost of procuring the *additional* machines and appliances that will be required, and of altering and enlarging some of those on hand and of installing these machines and appliances at each of the arsenals.

A summary of all these estimates gives for the cost of removing plant on hand to each arsenal, installing the same, including some necessary alterations and repairs of buildings and furnishing power:

Total for Watervliet Arsenal	$9,500.39
Total for Frankford Arsenal	11,238.46

The estimated cost of additional machines and appliances of altering and enlarging those on hand to increase the plant to the capacity required, and of installing the same, is:

Total for Watervliet Arsenal	$11,705.00
Total for Frankford Arsenal	11,780.00

As the commanding officer of the Watertown Arsenal states that the experimental 5-inch B. L. siege rifle is nearly completed, and can be finished by June 1, proximo, the above estimates are made on the supposition that this gun would be finished at that arsenal.

The Board has included in its lists all the machines at the three arsenals which can be used advantageously on gun work, without regard to the injury which might arise through any of these arsenals being deprived of machines required for other work; this is especially marked at Watertown. The advisability of such a course can be judged of only by the Department. If any of the machines selected should not be taken, they must be replaced in the gun plant by the purchase of *new* machines, which would increase the cost of the "additional machines and appliances," and the increased cost can be taken from the "price-list."

The Board considered the subject of the transfer of skilled workmen from Watertown Arsenal, and recommends that all workmen who will accept work at the place selected be employed there, as it would be advantageous to the Government to employ these men who have had experience on the work.

In the opinion of the Board more of these workmen would be willing to go to Watervliet than to Frankford because the cost of living is less at the former place, and because, the distance being less, many who have homes could retain them and visit their families occasionally until they are ready to remove them.

It is found upon examination that the two arsenals possess the following facilities for concentrating the plant now on hand, and for increasing the same to the capacity required for immediate gun work.

At the Watervliet Arsenal there is at present sufficient shop room for the work on the field and siege guns, and were it not for the sustaining columns of the second floor and roof there would be room enough to set up and use the machines and tools necessary for making all the guns, both great and small. But these columns would interfere with the work on the sea-coast guns, and in consequence it is necessary to take another building for this purpose. A suitable one is found in a brick timber store-house situated west of the canal, and marked 38 on the plan of Watervliet Arsenal.

The lathes and other machines and tools necessary to make the 25 field guns per annum, and the 7-inch howitzer, would occupy a space in the front shop. The lathes or vertical boring mills needed for the hoops for sea-coast guns, and all the other machines for the work, except the lathes for turning and boring the large guns, would be placed in this shop, where there is plenty of room and both steam and water power, leaving the two large lathes and the shrinking apparatus to be placed in the brick store-house, the power for which can be supplied by the portable engine of 12-horse power now at Watertown Arsenal.

The shrinking crane may be that now used for small guns at Watertown Arsenal, which can be transported bodily and enlarged and strengthened for the work required. The 30-foot posts in this crane being sufficiently strong can be used in the construction, but the present cross-beams and hoisting apparatus will have to be replaced by stronger ones. A heating furnace will also have to be constructed.

The above is thought to be the best practicable arrangement for this work if it is done at Watervliet, and the plan shows the proposed arrangement and location of the machines.

The advantages of setting up the plant at Watervliet are:

1. The existence of plenty of shop room all ready, with power, for all the machines and tools except the largest lathes.

2. There being a building easily transformed into a convenient shop for the heavy work, situated on the ground which has already been, and would probably again be, selected for the location of the additional permanent shops.

The disadvantage is the cost of the alteration of this latter building from a timber store-house into a shop, and the fact that the two buildings are not in immediate proximity.

At the Frankford Arsenal it is found that there is no building available except the rolling-mill, a fine large building which is now used as a store-house. There is floor space in this, by using both floors, to set up all the machinery necessary to do the work for the 25 field guns, the 7-inch howitzer, and the two sea-coast guns. There is also an opportunity to dig the shrinking pit and set up the hoisting crane in the building. This building has no power in it. The base of a stack is built but the superstructure was never built. The building sets too high from the ground to be convenient for gun work.

The large lathes would occupy the east wing, while the other machine tools would be placed along the front and west wing. For the shrinking arrangements, parts of the hoisting apparatus once used for the Woodbridge brazed wire guns can be utilized, but the furnaces then used and now existing are not suitable for the present work, and it would be necessary to remove them and build a new heating furnace.

For power to run all the machines, both heavy and light, it will require at least 60-horse power. The Department has at Watertown Arsenal a 100-horse power engine and two 48-inch by 16-feet boilers. There are also two spare boilers (old) at the Frankford Arsenal, and in the estimates herewith it is contemplated to use the two boilers now at Frankford in connection with the 100-horse power engine from Watertown, and also to erect a temporary iron stack in lieu of a permanent brick stack.

The above is the best practicable arrangement if this contemplated work is done at the Frankford Arsenal. The plan herewith (see drawing No. 13) shows the proposed location of machinery.

The facilities offered by Frankford Arsenal for this work consist alone of the large rolling-mill building, presenting area sufficient to permit of doing all the work under one roof.

The objections are the inconvenient elevation of the building above the ground level and the bad arrangement of columns in the floor space, and the expense of fitting up with the power and shafting necessary.

In comparing the existing facilities of the two arsenals, it is seen that the work can be prosecuted at either place, but that Watervliet possesses greater facilities for immediate work in that it has shops and power in readiness to commence the light work, and that with no great expenditure of time and money the brick timber store-house can be altered into a convenient shop in which to set up the two large lathes, the portable engine to run them, and the shrinking crane and heating furnaces.

It is therefore the opinion of the Board that the Watervliet Arsenal offers better advantages than the Frankford Arsenal for the effective and speedy establishment of a gun plant sufficient for immediate wants, and the estimates show that the concentration can be effected more cheaply at the Watervliet Arsenal.

Site for a fully equipped gun factory.

Some of the more important conditions which a suitable site for a gun factory should satisfy are the following:

There must be room for all constructions and operations which the future wants of the country may demand from such an establishment.

There must be sufficient foundations for all the necessary structures and machines.

There must be sufficient transportation facilities between the factory and the sources of supply of all material, and also between the factory and the points where its products are to be used.

A proof-butt or some other provision for firings incidental to gun construction is so desirable as to be almost a necessity.

Its location should be as safe as practicable from hostile operations, and where it would be least subject to, and easily protected from, labor or other domestic disturbances and mob attacks.

It should have a healthful location and as good a climate as practicable.

It should be so situated that the necessary force of skilled labor can be obtained, and it is desirable that there should be advantages for the settlement of the employés in the immediate vicinity.

Economy in fulfilling all these requirements should be considered.

In procuring information and in considering and weighing the comparative advantages of the Watervliet and Frankford Arsenals as sites for a gun factory, the Board has divided the subjects considered into the following heads:

Present facilities and possibilities for expansion.
Foundations.
Proof-butt or other firing facilities.
Facilities for railroad communication.
Facilities for water communication.
Facilities for transporting and receiving gun-metal.

Facilities for transporting and receiving coal.
Facilities for transporting and receiving manufacturers' supplies of all kinds.
Facilities for shipping and transporting guns to required points.
Convenience of proximity of gun factory to establishments that manufacture forgings.
Labor.
Safety from hostile operations.
Climate.
Health.

In considering these points the Board has not confined itself entirely to existing conditions but has endeavored to foresee and to take into account in its deliberations and conclusions the probable future growth of and changes in the country, and the consequent changes in the demand upon and in the conditions that would affect the efficiency of the fully equipped gun factory.

In this report the foregoing subjects are not considered in their regular order, but somewhat in the inverse order of their importance, and also similar subjects are sometimes considered together.

Health and climate.—The information obtained by the Board indicates that Frankford is now somewhat healthier and has a milder climate than Watervliet, but a dense population is growing up around Frankford; it has not as good drainage and healthful surroundings; it has not and is not likely to have in the future as good water as Watervliet, and with its warmer summer climate it should be more subject to epidemics. There is now no decided difference in the healthfulness of the two places, and the chances for improvement in this respect are in favor of Watervliet. The latter has the more rigorous climate and the lowest average temperature, causing out-door work to be more interfered with in winter, but causing workmen to accomplish more work per day in summer.

The climate and health of both places are now, and likely to remain, good enough to make them both suitable sites for a gun factory.

Safety from hostile operations.—Hostile operations may be by foreign fleets and armies, or they may result from domestic troubles.

Watervliet Arsenal may be considered absolutely safe from hostile fleets and vessels. Frankford Arsenal is not now safe from hostile fleets or even from a single powerful armored raiding vessel, but it can be so defended by fortifications, torpedoes, and a navy as to make it practically safe.

In case of a war with Great Britain, Watervliet is on a probable line of hostile operations and would be in greater danger of capture by a land force than an arsenal at Philadelphia.

A proper system of national defense would so protect these arsenals as to render either a sufficiently safe location for a large Government factory.

Hostile operations arising from domestic troubles may be of two kinds; those resulting from civil war and those resulting from riots and labor troubles. The latter are considered under the head of "Labor;" the former can not be foreseen and are not considered.

Labor.—This subject has been considered under several heads, viz, proximity to centers of skilled labor, and facilities for obtaining labor; character of workmen, wages, liability to discontent, strikes, and other troubles; and natural defensibility against mobs.

Frankford Arsenal being within the city of Philadelphia, a large manufacturing town, can draw from it all the skilled labor required.

Watervliet, on the other hand, would collect from the State of New York and from the highly skilled mechanics of New England the labor needed, which might not be in Troy or its immediate vicinity.

No difficulty could arise in obtaining at either point all the labor of any kind or quality that would be demanded.

Rents and the cost of living are less at West Troy than at Philadelphia, and the same quality of labor is cheaper at the former than at the latter place. A factory will always attract the workmen needed, and with them the permanency of the work has far more weight than any other consideration.

It is now generally believed desirable for a manufactory to be sufficiently removed from a large town to permit of not only ample room for shops but for the separation of its employés as much as possible from disturbing classes.

The Board is therefore of opinion that neither arsenal possesses a marked advantage over the other in the facility of obtaining skilled labor, but it believes that at Watervliet there would be less interference from strikes and other labor troubles, and that on account of its position it would be less subject to attack by hostile mobs and more readily defended from them.

Facilities for transportation; railroad and water communication, with sources of supply of materials required, and with points to which guns are to be shipped.

Railroad connections.—Frankford has now near wagon connection with one of the lines of the Pennsylvania system and through that system has excellent railroad connection with all parts of the country. A switch can be constructed quickly and cheaply to connect the shops with one of the Pennsylvania Company freight tracks.

Watervliet has now wagon connection with the New York Central system, the Delaware and Hudson system, and with the Boston and Albany and Troy and Boston Railroad. A switch can be constructed to connect the shops with one of the Delaware and Hudson Company tracks and give excellent railroad connection with all parts of the country.

Water connections.—Frankford has wharf facilities on the Frankford Creek for small coasting vessels, for lighters connecting with large seagoing vessels in the Delaware River, and for barges giving barge connection with Delaware River and Bay, and through the Delaware and Raritan Canal with New York Harbor and the Sandy Hook Proving Ground. With considerable expense a wharf for larger sea-going vessels could be constructed on the Delaware River, and this wharf could be connected with the shops by a railroad track.* This last construction would be a necessary part of the plan for taking guns down the river for firing.

The Lehigh Valley Canal debouches into the Delaware River at Bristol, about 15 miles above Frankford, giving barge connection with the Lehigh coal region, though this canal is little used, and these coals are brought to Philadelphia almost exclusively by rail.

Watervliet has excellent wharfage facilities on the Hudson River for small coasting vessels and for large barges. The Erie Canal, which runs through the grounds and debouches into the Hudson River near the arsenal, gives facilities for very cheap loading and unloading, and especially through slips, for cheap methods of loading heavy guns. This canal and the Hudson River give barge connection with New York Harbor, the Sandy Hook Proving Ground, and the New England coast as far as Narragansett Bay; through the Delaware and Raritan Canal with the Delaware River and Bay, and through the Delaware and Hudson Canal, which debouches into the Hudson River at Rondout, cheap barge connection with the coal-fields of Pennsylvania.

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*There is a question whether this wharf could be built out as far as deep water without acquiring additional land on the shore. The port wardens of Philadelphia decide that it cannot. It is the opinion of the commanding officer, Frankford Arsenal, that a suitable wharf could be built without procuring additional land.

The Erie Canal and its connections (the Champlain Canal and the Oswego Canal) gives water connection with the Great Lakes and the northern frontier.

Watervliet has the better water facilities for loading and unloading and for wharfage, except that Frankford can, with sufficient expense, have a wharf for large sea-going vessels and Watervliet can not.

Facilities for receiving coal.—Both places have unlimited facilities for the procurement of coals of all kinds, the only difference being in price due to difference in cost of transportation. Through the Delaware and Hudson Canal Watervliet has cheap water communication; and through the Delaware and Hudson Railroad, and its numerous connections via Binghamton, N. Y., and various roads north to the New York Central Railroad it has cheap railroad connection with the Wyoming Valley, one of the richest and best coal-fields of Pennsylvania. Via the same railroad (the Delaware and Hudson), and other roads to the Hudson River, and especially to New York, it has cheap connection with the same coal-fields, and also with the whole Lehigh coal region. Through the Delaware and Raritan Canal, and especially via coasting schooners, it has water connection with Lehigh coals brought over the Philadelphia and Reading Railroad to that company's wharves at Port Richmond. Through the Delaware and Hudson Railroad and its connections and various roads leading north to the New York Central Railroad it has cheap connection with the Blossburgh forging or smithing coal in Tioga County, Pa.

Philadelphia's railroad connection with the coal fields of Pennsylvania and northern Virginia are so well-known that they need hardly be described.

Through the Philadelphia and Reading system, and the Pennsylvania system and their connections, it has as cheap railroad transportation from the Wyoming coal fields as Troy, N. Y. (though perhaps not as cheap as the water transportation via the Delaware and Hudson Canal and the Hudson River to the latter point). It has somewhat cheaper railroad transportation routes from the Lehigh region than Troy has from the Wyoming region. For bituminous forging coals it has cheap railroad connection via the Pennsylvania Railroad with all of the Clearfield and Westmoreland regions and through the Baltimore and Ohio Railroad and connections with the Cumberland coals.

Lehigh is the standard coal for use in the best manufactures of steel and iron. As the steel is not to be manufactured by the Government not much of this coal will be required at the gun factory. The best coal from the Wyoming region (that from the Wyoming mines) is as good as the best Lehigh; while the lower grades of Lackawanna and Pittston from the Wyoming region are as good for steam making as the lower grades of Lehigh used for the same purpose.

Watervliet should procure its anthracite coals of all kinds from the Wyoming coal-fields nearly as cheaply as Frankford could from the Lehigh region. Not much anthracite is to be used except for steam making, and as Watervliet has water-power, less will be required at Watervliet than at Frankford. Watervliet's accessibility to the Blossburgh region, which furnishes the best forging coal in the country, makes its facilities in this respect certainly equal to those of Frankford. Bituminous coal would be required only for forging purposes. What has been said relates to the natural facilities of the two places for procuring coal, which should affect the prices of coal of all kinds at the two places in the future. How far these natural facilities will control prices can not be foretold. At present the price is determined by combinations of various kinds, and the price is so much less in New York Harbor than in Philadelphia, and barge transportation via the Hudson River is so cheap, that the prices of coals at Watervliet are as low during the navigation season as at Philadelphia.

The natural facilities are in favor of Frankford, but not much, and less should be required for consumption at Watervliet than at Frankford.

Facilities for receiving gun metal.—There are ample facilities for receiving gun metal at both places, the only difference being that of the cost of transportation. For forgings received from Midvale and Bethlehem this difference by both water and rail is now about $2 per ton in favor of Frankford; that is, about one-fourth of 1 per cent. of the price of the forgings.

For forgings received by water from Cleveland the difference is in favor of Watervliet, and for these received from Johnstown, Pa., it is somewhat in favor of Frankford. For steel manufactured in the vicinity of Scranton, Pa., or further west, on the Hudson River, or in New England, the cost would be in favor of Watervliet.

The value of the Champlain and Chateaugay ores is well known, and is increasing steel manufacture at Troy and on the Hudson River. The value of Lake Superior, Missouri, Tennessee, and Alabama ores causes a movement of steel production westward, and, in consequence of Watervliet's Erie Canal connections, it might become in the future the cheaper place for delivering steel. The difference of cost is now in favor of Frankford both for forgings and coal, but calculation makes the greatest probable difference increase the cost of a gun less than one-half of 1 per cent.

There is no material difference in favor of either place in its advantages for the procurement of manufacturers' supplies and various supplies of all kinds. Watervliet has a considerable advantage in the prices of building materials, lumber, and all supplies from the West.

Facilities for the shipment of guns.—These facilities have been discussed for both arsenals under the head of "water connections." From both places guns can be shipped by barge to the Sandy Hook Proving Ground, to all fortifications in New York Harbor and along a portion of the New England coast, and to the fortifications on the Delaware River and Bay, and by coasting vessels to all, or nearly all, of the fortifications on the Atlantic coast.

From Frankford nearly all the barge shipments would have to pass through the Delaware and Raritan Canal, while of those from Watervliet only those for the Delaware River and Bay would pass through this canal.

To this extent the facilities are much in favor of Watervliet, especially the better connection with Sandy Hook, as barges through the canal require the delay and expense of three kinds of towage, viz, by steam to the canal, by horse through the canal, and again by steam from the canal.

For shipments by small coasting vessels to points along the Atlantic coast, the facilities for both places are equal. For shipments by large sea-going vessels to the Gulf of Mexico and the Pacific coast, guns from Watervliet must be transferred to such vessels with a floating derrick in the New York Harbor. Those from Frankford can be transferred in the same way in the Delaware River, or a wharf for sea-going vessels can be built at Frankford. It is a question, however, whether the amount of such shipments would warrant the expense of the wharf.

Watervliet has much the better facilities for water shipment via the Erie Canal to the Great Lakes and the northern frontier, though barges from Frankford can reach this canal via the Delaware River, the Delaware and Raritan Canal, and the Hudson River.

Frankford has an advantage in the fact that its water transportation would be less interfered with by ice. The Delaware River remains open to Frankford, or can be kept open with ice-breakers throughout the year. The Delaware and Raritan Canal is closed generally about four months in each year.

Shipments from Watervliet via the Hudson River would be prevented generally about three months in a year. If it should be necessary to ship a gun during this period it could be transported from Watervliet over the West Shore Railroad to Hoboken, N. J. The Board is informed by the chief engineer of that road that its bridges would permit and that there would be no difficulty in transporting guns of 100 tons weight on special trucks provided therefor. The convenience of shipping in this way on cars loaded in the gun-shop might be such as to cause its use throughout the year.

Reviewing the whole subject of transportation, the procurement of supplies, and the shipment of guns, it may be said that the facilities of both places are ample. In some things there is a small difference of cost, sometimes in favor of one place, sometimes in favor of the other, and this difference is almost insignificant in its effect upon the cost of a gun. Watervliet has some advantage in its better wharfage, loading and unloading facilities, its better connection with New York Harbor and the Sandy Hook Proving Ground, and, through its Erie Canal connection, with the Great Lakes and the West. Frankford has an advantage in its cheaper transportation from some probable sources of supply of forgings and in its water transportation, being less obstructed by ice, and in the possibility of having its own wharf for large sea-going vessels, though this last advantage diminishes upon investigation.

Proximity to steel establishments that manufacture forgings.—What has been said under the head of transportation narrows this question down to one point, viz, the convenience of having the establishment that furnishes the forgings and the gun factory that finishes the gun near each other. For forgings manufactured at Midvale and Bethlehem, Frankford would have a decided advantage in this respect. For those made at Johnstown or Cleveland neither would have an advantage; which arsenal will be nearest the place of manufacture in the future can not now be determined or foreseen.

Proof butt or other firing facilities.—For tests of new types or for ballistic experiments the cannon must be sent to a proving ground. Sandy Hook, N. J., can be reached from either arsenal by water; at present the facilities for this are better from Watervliet than from Frankford.

For any firing incident to construction and for the proof of guns of adopted types, it is desirable that facilities for firing guns of all calibers should be at hand to avoid the necessity of sending the piece from the factory.

At Watervliet Arsenal it is believed that within the grounds themselves such an arrangement could be made as would answer the requirements for guns of moderate size and perhaps for guns of very large caliber. Outside of the grounds, within half a mile, there are hills and gorges where it is practicable to arrange an entirely satisfactory place for guns of any caliber to be fired.

At Frankford Arsenal itself there are no facilities for making a proof butt, or any other arrangement for firing any guns; nor is there any place in the immediate vicinity which would permit of such firing. Possibly a large barge might be constructed to carry the gun, and a modified carriage which might be towed down the Delaware River about 50 miles to some unoccupied marsh land, where at considerable expense, a butt might be constructed and fired into from the large barge moored near the shore. It is difficult to say whether or not this method is entirely feasible, but it is certain that it would be costly and difficult of accomplishment and inconvenient if consummated. If the butt could not be constructed, possibly firings sufficient for the purpose required could be made over water in the same vicinity, though such firings are objectionable.

From this statement of the facilities at the two arsenals for firing guns, it is evident that Watervliet possesses in this respect advantages far superior to Frankford.

Foundations.—At Frankford Arsenal there is no rock foundation. From 3 to 4 feet below the ground surface there is a bed of gravel generally from 8 to 9 feet thick. Below this, generally about 12 feet from the ground surface, there is a layer of from 2 to 3 feet of good tough clay. Below this is a deep bed of coarse gravel, pebbles, bowlders, and white sand, communicating with the river and full of water. By digging about 3 feet into the upper bed of gravel, that is, about 6 to 7 feet below the ground surface, a fair foundation is obtained for buildings and ordinary machines. Near the boundary, between the high ground and marsh, this depth increases to about 9 feet. Pits and other excavations can be carried down to the bed of clay without material trouble with water. Excavations through the clay, or to a depth generally greater than 13 feet, are nearly impracticable on account of water. A water shield would be required and expensive methods of digging and pumping. Foundations below the clay are uncertain.

At Watervliet Arsenal, below the canal, there is good rock foundation at a depth of about 20 feet, and water is encountered in digging. There is hard earth foundation usually at a depth of about 9 feet, which is sufficient for ordinary buildings and machines. All the buildings required in this part of the grounds are already erected.

In the grounds above the canal there is a deep strata of shale or slate rock cropping out which furnishes with the least cost an absolutely perfect foundation for buildings, heavy machines, and constructions of all kinds, including heavy hammers and dry pits. This is the site which has been selected at this arsenal for the factory for heavy guns.

In the excellence of its foundations at the site of the proposed new works Watervliet Arsenal has a decided advantage.

Present facilities and possibilities for expansion.—This includes the facilities only as regards present buildings and grounds, and the possibilities of their expansion.

At a well-equipped gun-factory, buildings are needed for shops, for store-houses, for offices and quarters, and sufficient land is needed to conveniently locate them and the railway tracks and proof firing-butt. The amount of land at the arsenals under consideration is: At Watervliet, 109 acres, and at Frankford 63 acres. At the former place the grounds are divided into two parts by the Erie Canal; that east of the canal being little higher than the river level. This is sometimes in the spring overflowed for a few days, but it has never to any great extent interfered with work in the shops situated thereon. The west part is considerably higher and offers good, unobstructed sites for extensive buildings. In rear of the arsenal, that is west of it, unoccupied fields present an opportunity for expansion in that direction if more ground is needed in the future.

The buildings which can be utilized at this arsenal have before been referred to. They consist, east of the canal, of: (1) The present large shop building (including designations 7, 8, 9, 11 and 14, on the map of the arsenal, drawing No. 8) provided with four water-wheels and a 150 horse-power engine. The south wing of this building and the forging shop are older, and in some respects not suitable for gun work. (2) The iron store-house (marked 5); while west of the canal are the two brick timber store-houses (marked 38 and 41), susceptible of conversion into good shops for heavy work. All these buildings together will furnish an area of 154,295 square feet, which can, without great expense, be used as shops for the gun factory. Store-houses, offices, and quarters exist to an extent that would be sufficient for present wants.

At Frankford Arsenal the grounds as a whole are lower with reference to the river than at Watervliet, and a small portion is marshy and below the water level at high tide. That portion available for buildings is much smaller than at Watervliet, and there is no opportunity to expand beyond the present limits of the arsenal. The buildings now existing which could be used for the gun-factory consist of the rolling-mill and the machine-shops (drawings Nos. 9 and 10). The latter building, as it is, would only be useful for light finishing work, and is not suitable for general gun work; in the event of enlargement it would probably have to be removed to make room for larger buildings better adapted to the work. The whole shop room area would be 47,338 square feet. The present store-houses, offices and quarters, would be sufficient for some time to come.

Although the present gun plant of the department can be established at either of these arsenals without interfering with the work now prosecuted there, as soon as it becomes necessary to make larger guns or a greater number of the size now projected, additional buildings would be required. These now exist at Watervliet, whilst there are none whatever at Frankford.

With the fullest use of all the ground at Frankford it is deemed insufficient in capacity for the convenient arrangement of a well equipped gun-factory; it would be inadequate to future wants, and as contiguous ground for expansion can not be obtained, it is much inferior to Watervliet in this respect.

CONCLUSION.

After careful consideration of all the points discussed, the Board finds that in all matters except the following, there is no decided superiority in one of these arsenals over the other:

Watervliet provides excellent foundations, whereas Frankford does not; firing facilities can be obtained at Watervliet but not at Frankford; the former has better facilities for labor, and its water connection with the northern frontier if of importance; but its great and important advantages over Frankford are that the immediate concentration of the department's gun plant can be there effected more cheaply, that it has larger and better buildings and more ground for immediate expansion, and that unoccupied adjacent lands furnish the possibility of extension in the distant future into so great an establishment as the future wants of the country may demand.

What these future wants may be is indicated by the magnitude of the armaments that will be required as stated in the report of the Gun-Factory Board, 1886, the report of the House Committee on Ordnance, first session Forty-ninth Congress, 1886, the report of the Board on Fortifications, 1886, and the fact that history shows that these armaments will change and require removal.

The Board is of the opinion that Watervliet Arsenal is better adapted than Frankford for the concentration and installation of the present gun plant of the department, and for the establishment of a fully equipped gun-factory.

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